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INSURANCE AND THE COMMERCIALIZATION OF SPACE

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HON. JOHN C. DANFORTH, *Chairman*

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LETTER OF TRANSMITTAL

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC, March 13, 1985.

DEAR COLLEAGUE: The Committee on Commerce, Science, and Transportation and the Subcommittee on Science, Technology, and Space are pleased to submit this report on insurance and the commercialization of space.

We are just beginning to realize the commercial promise of space. The White House National Policy on the Commercial Use of Space and Congressional enactment of the Commercial Space Launch Act (P.L. 98–575) and the Land Remote-Sensing Commercialization Act (P.L. 98–365) portend the commercial era of space. However, as is often the case with an emerging industry, there are potential barriers to commercialization. One major concern in the space commercialization industry is the availability of insurance at an affordable cost.

It was a desire to improve our understanding of the relationship between insurance and the commercialization of space that prompted several Members of this Committee (Senators Hollings, Gorton, and Heflin) to request a study of the subject by the Congressional Research Service.

We hope this report furthers public knowledge on the issue of insurance and space commercialization and that it makes people more aware of the challenges confronting this dynamic new industry.

Sincerely,

JOHN C. DANFORTH, *Chairman.*

LETTER OF SUBMITTAL

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC, March 11, 1985.

Hon. JOHN DANFORTH,
Chairman, Committee on Commerce, Science, and Transportation, U.S. Senate, Washington, DC.

DEAR MR. CHAIRMAN: We are pleased to transmit a report by the Congressional Research Service, prepared at our request, evaluating insurance and its potential effect upon the commercialization of space.

As you are well aware, the United States recently entered the commercial era of space. However, as is so often the case with emerging industries, there are barriers that need to be overcome.

During the course of the Committee's involvement in drafting the Commercial Space Launch Act (P.L. 98–575), we became aware of the economic ramifications of the insurance costs associated with commerical space ventures. To better understand this potential barrier, we requested that the Congressional Research Service do a report on the short and long-term implications of insurance costs on the commercial potential of space and how insurance rates could affect the ability of domestic commercial space firms and the space shuttle to compete in international markets.

This CRS report should help the Congress and others identify those questions and various options to deal with them. We hope this report will be made available widely.

Sincerely,

SLADE GORTON,
Subcommittee Chairman.
ERNEST F. HOLLINGS,
Ranking Democrat.
HOWELL HELFIN.

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CONGRESSIONAL RESEARCH SERVICE,
THE LIBRARY OF CONGRESS,
Washington, DC, March 5, 1985.

Hon. SLADE GORTON,
Hon. ERNEST HOLLINGS,
Committee on Commerce, Science, and Transportation,
U.S. Senate, Washington, DC.

DEAR SENATORS GORTON AND HOLLINGS: We are pleased to transmit to you herewith the report you requested on insurance and the commercialization of space. The report was written by Jane G. Gravelle, Specialist in Industry Analysis and Finance, and David L. Whiteman, Analyst in Industry Economics, both of the Economics Division. Marcia S. Smith, Specialist in Aerospace and Telecommunications Systems in the Science Policy Research Division, provided technical expertise on aspects of space activities that reflect on insurance rates, and was the overall coordinator of the project.

We hope that this report meets your needs. If we can be of further assistance, please let us know. With best regards,

Sincerely,

GILBERT GUDE, *Director.*

THE IMPACT OF INSURANCE ON THE COMMERCIALIZATION OF SPACE

Introduction and Summary

In 1981, following the first successful test mission of the space shuttle, optimism regarding the potential for insuring space exploration was high. The shuttle was characterized as the future "long-haul truck of outer space" and the then chairman of the first company organized exclusively to provide space insurance, James Barrett, said "we expect that outer space industry will become a giant business, generating up to $2 billion in premiums in the next decade." [1] With that decade nearly half over, the space insurance industry's expectations have diminished markedly. The coverage capacity of the industry contracted considerably following the three satellite losses in the first half of 1984.

Space underwriters and officials interested in promoting commercial space initiatives are dealing with the current capacity constraints by not insuring for full and raising rates. In order to limit the risk exposure of the underwriters, the industry is discussing options such as extremely high deductibles, providing indemnification for partial loss, and restricting coverage to some of the less risky phases of launch operations. Another major space project loss in the near future would probably have a severe impact on a fragile, already highly stressed market. Moreover, the movement of the industry toward certain procedures such as partial coverage, large deductibles, and partial indemnification could hamper the development of a competitive space industry by squeezing out small firms that require insurance coverage and cannot self insure.

An examination of the history of the space insurance industry suggests that there has been considerable instability in the market for a number of years. The industry is characterized by a relatively small number of participants and the number of commercial space launches has been small relative to numbers that occur in most activities which involve insurance. A single launch failure or other loss has frequently caused marked changes in the industry. The most recent effects of the three satellite launch failures in 1984 are, therefore, not atypical of a pattern which had already been established. This instability of the market can be traced to a number of factors. Most outstanding are the large values involved in a single launch which can dramatically change the cash-flow position of the industry, and the constantly evolving technology which make the assessment of risk very difficult. It may be fair to say that reliable actuarial measures have yet to be developed.

When more experience occurs and if the technology stabilizes, the private space insurance market should be able to provide insur-

[1] Business Insurance. "Shuttle Returns Home Safe and Insured." Apr. 20, 1985, pp. 1, 26.

ance in a fashion which will contribute to a stable, competitive commercial space industry. At the current time, however, the space insurance industry continues to be characterized by certain conditions which are suggestive of "market failure" and which may justify some Government intervention.[2] The consequences of this market failure might lead to a restriction of the involvement of small and medium-sized firms in space commercialization. The consequences may also hamper the development of certain types of commercial space development, such as manufacturing in space, which will involve repeated launches for which insurance may not be obtainable in advance.

There are a number of precedents for Government involvement in insurance which may contain some lessons for the question of government insurance for activities in space. The Government has occasionally stepped in to provide coverage which is not offered in the commercial markets, or which may be deemed to be provided at undesirable rates. Two programs which appear to relate specifically to the current issue are the provision of liability limits for nuclear powerplants and the provision of flood insurance. The former related to aiding a developing industry characterized by potentially large losses and technological uncertainty. The flood insurance program involved a situation where lack of information was crucial and where the Government has stepped in with the intention of eventually converting the program to a system of privately provided insurance.

Space insurance has been provided by private markets for a number of years. Although there is evidence of market failure in the space insurance industry, and there are precedents for Government involvement in insurance, one cannot easily assess the desirability of Government intervention. Market failures are pervasive in any economy. Most such failures, however, persist because they are not deemed important enough to correct. The harmful effects of the market failure must be weighed against costs of Government subsidies, and such effects and costs are often not possible to quantify. Whether the Government should intervene must, therefore, be a largely judgmental assessment of the alternative consequences.

If some Government intervention is deemed desirable, there are several forms it might take. One of the problems with space insurance is the complex and changing technology which causes information problems. The Government might intervene to aid in the provision of reliable information on the technological risks involved in the various aspects of space commercialization. A second option might be to provide insurance for those smaller firms which are most likely to be severely affected by large deductibles, partial coverage, and copayments. Or, the Government might step in as an insurer of the last resort to provide coverage where it otherwise

[2] The term "market failure" is commonly used in economics. It does not imply that a market is not working, but rather than the market fails to provide the most efficient set of prices and quantitites. Market failures are pervasive in the economy and most are not generally deemed severe enough to warrant Government involvement. Market failures do tend to be quite important in insurance, and the Government is quite involved in regulating and providing insurance of various kinds. Whether a market failure is severe enough to suggest Government involvement is largely judgmental in cases where quantitive measures of efficiency cannot easily be made.

cannot be obtained, or to provide coverage where only partial insurance is provided or where large deductible are required. In addition, the Government could provide coverage and even subsidized rates for areas of space commercialization which are deemed to be most important and most severely impacted by characteristics of the private markets. Such activities might, for example, include guarantees for serial launches in the case of space manufacturing endeavors.

The Space Insurance Industry: A Background

In even a casual study of the space insurance industry, one feature which stands out is the influence of single events of failed launches on the industry. This characteristic is indicative of some of the particular problems in the industry which make it atypical of the insurance business and which relate to questions of market failure discussed in the next section. It is, in turn, the question of market failure on which the issue of Government intervention may largely rest.

Existing space insurance experience relates primarily to satellites, and particularly to communications satellites. Some of these same problems would also be associated with developing areas of space commercialization, such as materials processing in space, although there are some issues unique to space manufacturing. The characteristics of the space insurance industry which have been observed in the past 20 years, particularly in the property loss area, can have important implications for the commercialization of space in general.

This section of the study provides general factual background on the industry with particular attention to those aspects which relate to the possibility of market failure. First, a brief description of the types of insurance written and the major institutional features of the market is provided. Second, a history of the market experience is provided. In the following section, the characteristics which seem important to assessing the issue of the Government intervention in the market are addressed. The existing experience has been with communications satellites. Some of the characteristics which have influenced the market, such as large losses from single events and a complex technology, will apply to other commercial space applications.

BASIC INSTITUTIONAL CHARACTERISTICS OF THE SPACE INSURANCE MARKET

A variety of types of insurance may be purchased when a satellites or other object is to be launched.[3] There are several stages at which insurance may be purchased to cover property risks. Prelaunch insurance may be purchased to cover risks associated with the manufacture and transport of satellites to launch sites. Included in the insurable risks might be coverage related to potential damage to the satellites on the ground as well as the risk of delay

[3] The description of types of satellite insurance coverage relies primarily on Johnson & Higgins. "A Report on Spacecraft Insurance." New York, 1983.

in delivery. Some of the insurance for these risks may be purchased by the satellite manufacturer.

The next stage of property insurance covers the risk of not placing the satellite in the proper orbit. Launch coverage typically involves the greatest risk and is the major focus of the discussion of satellite insurance. Insurance may be purchased to cover cost of replacing the lost satellite, of relaunching the new satellite, and of lost revenues associated with delay in provision of service due to launch failure. This coverage typically extends 180 days beyond the launch date.

The third stage of property insurance is for the risk of satellite failure in orbit. It is possible to combine these stages, or even to separate them further. For example, the 1984 losses of the Palapa and Wastar were traced to failure of the payload assist module [PAM] which injects the satellite from its low earth orbit where it is deployed by the space shuttle to its final "geostationary" orbit over the equator.[4]

In addition to property insurance, satellite owners are required to purchase liability insurance in the amount of $500 million to cover the possibility of damage to third parties. The National Aeronautics and Space administration [NASA] has arranged for a single, third-party liability contract for the space shuttle (where there are multiple payloads) totaling $750 million with all parties sharing the insurance fee jointly. In the case of shuttle launches, there is also the possibility of one payload damaging another or the shuttle. NASA contracts preclude liability for damage to other property carried on the shuttle or for damage to the shuttle itself, so that liability coverage of this type is not required.

The most costly part of the insurance, at least for expensive satellites which can involve coverage of over $100 million, is the launch coverage itself.[5] Prelaunch insurance involves a premium of 0.01 to 0.05 cents per $100,000 and is negligible. The cost of in-orbit insurance generally is higher, involving a premium of 1 to 2 percent of satellite value. Third-party liability coverage in a shared shuttle launch (where the satellite would typically represent about a quarter to a third of the payload) would involve a cost of $100,000 to $150,000. Coverage would be higher when using expendable launch vehicles [ELV's] such as the Delta where only single loads are launched.

Launch coverage is considerably more costly, although it varies over time, and by type of launch vehicle. Prior to the 1984 losses of the Westar and Palapa satellites, rates were about 5 percent for the space shuttle, 10 percent for the European Ariane rocket (which is relatively new to the market), and 5 to 7.5 percent for the Delta and Atlas Centaur rockets.[6] Rates were predicted to double

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[4] A geostationary orbit is one in which the satellite remains at a fixed position over a point on the Earth's surface. Such orbits are not required for all space objects, but only for those that benefit from this vantage point, such as communications, some weather and some scientific satellites.

[5] Rates reported here are largely drawn from a report by Alice L. Cornish, of Shearson Lehman/American Express published in the November 1984, issue of Space, hereinafter referred to as the Shearson Lehman/American Express report, and reprinted as an appendix to this report.

[6] The Washington Post, Washington Business. "Perilous Business of Launching Satellites Not for the Squeamish." June 18, 1984. p. 21.

or even more than double in the wake of the 1984 losses, which included the loss of a third satellite in June 1984. Brazilsat and Arabsat paid record rates of 20 percent for a launch on the Ariane (February 8 of this year) and experienced problems securing even minimal ($25 million) coverage. Premiums for Arabsat's May shuttle launch will be 15 percent, but Aussat 1 scheduled for an August shuttle launch may have to obtain coverage from the Australian Government.[7]

Like any area of insurance, there are both brokers who arrange (place) the contracts and underwriters who rate and bear the risk.[8] The major U.S. brokers are Alexander & Alexander; Corroon & Black Inspace; Frank B. Hall; Johnson & Higgins; Knaush, Hogan & Maurrey; and Marsh & McClennan. Because much of the underwriting is provided by London underwriters, these U.S. brokers have a working relationship with Lloyd's brokers. The firms work respectively with Leslie Godwin, Ltd.; Crawley, Warren Ltd.; Sedgwick & Forbes; Willis, Faber & Dumas, Ltd.; Sedgwick & Forbes and C.T. Bowring.

About 70 percent of insurance is placed with British syndicates, the most important of which are the Merrett-Dixie syndicate and the Ariel syndicate.[9] The major U.S. groups are U.S. Aviation Insurance Group [USAIG], Aviation Office of America, Lexington Aviation Insurance Group, and International Technology Underwriters [INTEC]. INTEC acts as an underwriting manager for 100 reinsurance companies.

HISTORY OF THE SATELLITE INSURANCE MARKET

When the space program began to evolve beyond its scientific and national-security-related origins to include the launching of commercial projects, namely telecommunications satellites, the necessity for insurance protection arose. Those first approached were aviation insurance brokers and underwriters.

There was, of course, no experience data upon which insurance judgments relating to satellites could be premised. Despite some initial caution, the aviation specialists began to perceive space insurance as a new opportunity with greater growth and profit potential compared to the market for conventional coverages and a market for space insurance products began to develop.

The first satellite insurance contract, written for Intelsat's Early Bird in 1965, provided for prelaunch coverage.[10] Apparently the U.S. satellite company, Comsat, which serves as the U.S. representative to Intelsat, was interested in and negotiating for a physical damage contract and decided that it was too expensive, but did purchase a third party liability contract.[11]

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[7] Aerospace America. "Aerospace Spotlight." March 1985. p. 1.

[8] Identification of the major participants is based on the Shearson Lehman/American Express report.

[9] The 70-percent share is reported by Shearson Lehman/American Express. The Journal of Commerce reported in "Satellite Insurance Premiums Soar," (Aug. 29, 1984) that London underwriters hold 50 percent of the market, the United States holds 35 percent, and the remainder is held by the French.

[10] Shearson Lehman/American Express report.

[11] Testimony of Brian Hughes, of U.S. Aviation Underwriters, Inc., U.S. House of Representatives. Committee on Science and Technology. Subcommittees on Natural Resources and environ-

Continued

After a satellite was lost in 1968, Comsat sought launch insurance. The policy insured for one loss in a series of five launches with a one-satellite loss deductible. Generally, these early policies involved satellite deductibles, with payment not made, for example, for the first loss in a five-satellite series. The use of satellite deductibles continued until 1975, when insurers began to waive their requirements.

The first years of satellite insurance were relatively uneventful. The first major satellite loss, the European Space Agency's (ESA) orbital test satellite (OTS–1), in the amount of $29 million in 1977 was a shock to the industry. This single loss, using the Thor-Delta rocket launch, wiped out a large proportion of the premiums collected in all of the previous years of space insurance.[12] Although a number of firms new to the business, particularly in the ESA member states, withdrew from the market, the premium rose only slightly, from 7.2 to 7.9 percent for the next Delta launch of the OTS–2.[13] This initial loss involved a launch failure which has tended to be more common than in-orbit failure. This loss was followed in 1978 by loss of the Japanese ECS satellite which involved a rocket stage separation problem and resulted in a $12 million loss.

Following these events some concern about the coming space shuttle was expressed. Actually, the space shuttle was thought to be relatively safe as it was "man-rated" and designed to carry astronauts as well as cargo. As a new system, however, there was no data base to set rates. Moreover, some concern was expressed about the value of the payloads. While the value of the payloads on the Delta and Atlas Centaur rockets averaged $30 to $50 million, the shuttle was expected to carry multiple payloads with a total value in the neighborhood of $100 million.[14] Although one of the advantages of the shuttle was its ability to carry multiple payloads, this scale economy was a disadvantage as far as the launch insurance was concerned.

The first year of spectacular loss was 1979 when RCA's Satcom F–3 was lost due to failure in the apogee motor, an upper stage motor which places the satellite into its final orbital location. The claim for this failure was $77 million. The $77 million loss brought claims well above the total sum of premiums taken in to that point.[15]

The effect of the 1979 loss on both the cash position and attitude of the insurers was pronounced. Although there were no major fi-

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ment and on Space Science and Applications. Hearings on "The Commercialization of Meteorological and Land Remote Sensing Satellites." 98th Congress, 1st session, April, June, and November 1983, p. 729. Hereafter referred to as the Hughes testimony.

[12] Ibid. Mr. Hughes indicated that the loss eliminated all of the premiums collected since 1965. A. H. Bolton of C.T. Bowring states that the 1977 loss wiped out "most" of the premium income (Aerospace Daily, June 1, 1983, p. 176). The European Space Agency claimed (ESA Bulletin No. 16, 1978, p. 67) that two-thirds of premium income was wiped out. Of course, in most insurance business most premiums are paid out in claims. The startling point here is that a single event can loom so large.

[13] ESA Bulletin No. 16, 1978, p. 67.

[14] Aviation Week and Space Technology. "Shuttle Expected to Increase Insurance." Apr. 30, 1979, p. 153.

[15] According to the Hughes testimony, the industry at that point had paid out $3 in claims for every dollar of premium income.

nancial losses in the next 2 years, there were other losses.[16] Speculation was that premiums could rise from the existing value of 6 percent to 20 percent, or even 30 percent with further losses. The same report indicated uncertainty about the prospective new launchers—the Shuttle and Ariane.

Although 1980 and 1981 were years with no commercial losses, the industry was still in a large deficit position in early 1981, with claims of $125 million paid on the 1977, 1978, and 1979 losses. These were well in excess of the $85 million in premiums paid in at that time.[17] These comparisons do not take into account the investment income on premiums which accumulated for some time in earlier years. The deficit position has worsened considerably at the present time and investment earnings are not adequate to offset cash losses.

Premium rates were reported in the neighborhood of 13 to 16 percent in August 1981.[18] *Satellite Week,* however, reported an 8-percent rate for India's Insat I-A.[19]

The loss free years of 1980 and 1981 ended in 1982 when India's Insat I-A failed in orbit after 6 months, with a claim of $65 million followed by the loss of Marecs B on an Ariane with a $20 million claim.[20] The Ariane failure would have been more costly to the industry if the Marecs B had been insured for its full value (Marecs A was insured for $96 million) and had the other satellite on Ariane, the Sirio II meterological satellite owned by the Italian Government, been insured. The Marecs B involved a satellite deductible provision. In addition, a third loss involving a transponder failure in the seventh year of service of the RCA Satcom II brought total losses between September 1982 and July 1983 to $110 million.[21] Only the loss of Marecs B on the Ariane involved a launch failure.

The Insat I-A failure, the largest of the losses, led to some concerns in the market. *Satellite Week* carried a story focusing on the need to create a new information system. The article stated:

> Problems of Insat I-A, covered in detail in these pages for the last few weeks, has made pioneer space insurers believe they need to insist on considerably more disclosure with enhanced details concerning specific preflight performance of satellite and launcher components, with accurate, immediate release of pertinent information prior to and following launch.[22]

Several options were discussed, including a standard form of disclosure or an independent observer. This discussion suggests that the industry was increasingly beginning to feel an information gap.

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[16] Satellite Week reported underwriters' concern with the loss of an NOAA-B meteorological satellite due to failure of an Atlas launcher in May 1980, the June 1980 failure of the Ariane (French) expendible launch vehicle, the loss of an Air Force meteorological satellite following the failure of the Thiokil third stage, and deommissioning of the Japanese Yuri broadcast satellite due to a power supply failure. Satellite Week. "Space Risk Jitters." Aug. 11, 1980. p. 1-2. Even losses which were not insured caused some concern.

[17] Journal of Commerce. "Satellite Seen Insurer Opportunity." Apr. 6, 1981, p. 6A.

[18] Business Insurance. "Satellite Insurers See Profits in the Stars." Aug. 10, 1981, p. 80.

[19] Staellite Week. Nov. 9, 1981, p. 2.

[20] Statement of A.H. Bolton in Aerospace Daily, June 1, 1983, p. 176.

[21] Johnson and Higgins. A Report on Spacecraft Insurance. New York, 1983, p. 7.

[22] Satellite Week. Space Insurers Look for Better Actuary. July 5, 1982, p. 3.

The Insat 1-A and the Marecs B losses led to speculation that premiums would rise again from the 5- to 7-percent range to the 12- to 15-percent level.[23] Other concerns were voiced as well. James Barrett, president of INTEC, noted that some policies insured more than the actual value. He also noted that "as more companies take advantage of the weightlessness of space for manufacturing, demand for process insurance to cover the output of orbiting plant will increase." [24] He also speculated that interest might develop for additional insurance coverage for war risk, sabotage, and wrongful acts.

In any case, NASA general counsel Neil Hosenball characterized the industry as "jittery" at the beginning of 1983.[25] These fears were calmed somewhat, when 1983 proved to be a relatively uneventful year. The industry finished in a net negative cash position, but losses were down to $20 million.[26] Premiums were, as noted earlier, down to typical levels with a somewhat higher premium charged for the Ariane.[27]

The following year, 1984, set records for losses, however. Two satellites, Indonesia's Palapa 2-B and Western Union's Westar VI, although successfully deployed from the shuttle in February, failed to achieve geostationary orbit due to the failure of the payload assist modules. The Palapa was insured for $75 million and the Westar for $105 million bringing total claims to $180 million and placing the industry in a large net loss position. The loss led to a speculation that rates would rise to at least 25 to 30 percent.[28]

This loss was followed closely by the failure of the Intelsat V F-9, launched by an Atlas Centaur launch vehicle in June. The Intelsat satellite was insured for $102 million bringing the total loss in the first half of the year to over $280 million. Although loss of the Intelsat added to the industry's problems, its effect on the industry was not as great as that of the Palapa and Westar losses. First, Intelsat would pay an additional premium. Their premium on a five-satellite package rises from $24 million to $44 million as a result of the loss. Second, according to Richard Knausch, of Knausch, Hogan, & Murray, the loss of the Intelsat satellite did not have the same implications because of the launch vehicle. The February failure was more important because it was two satellites and because they involved a launch which used to practically guarantee success.[29] Of course, the failure was due to the PAM and not the shuttle itself.

The Atlas Centaur was a newly modified version, but the launch vehicle is usually reliable, having launched 40 satellites in a row without failure. Nevertheless, the multiple losses shook the industry. Richard Rankin of Corroon & Black Inspace, states: "What has happened has ominous tones . . . The feeling is that it is more of a confidence factor now—that the satellite technology may not totally have its act together—and that leaves underwriters wonder-

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[23] Business Insurance. "Satellite Insurers Try to Recoup Losses." Sept. 20, 1982, p. 2.
[24] Business Insurance. "Satellite Capacities Become Strained." Oct. 25, 1982, p. 41.
[25] Aerospace Daily. "Shuttle Payload Insurance Facility Proposed.' Jan. 12, 1983, p. 60.
[26] Shearson Lehman/American Express report, p. 9.
[27] See footnote 6.
[28] Aviation Week and Space Technology. Feb. 20, 1984, p. 25.
[29] Business Insurance. "Changes Looming for Satellite Coverage." June 18, 1984, p. 26.

ing." [30] He further suggested that rates would rise, and perhaps double in some cases, and that the industry might return to the one satellite deductible policy which had been the practice in earlier years. In the latter case, he noted, the business would be a game "only big boys can play." [31]

Brian Hughes, of the U.S. Aircraft Insurance Group, also expressed some concerns. He noted: "Space is a very risky business. Understand that insurance is the losses of the few being shared by the many. However, in the case of space insurance, there are not many people available to share the losses. There is not the spread of risk." [32] Insurers were beginning to express concern not only about the price, but the availability of insurance.

One effect of the losses was the withdrawal of Orion Insurance Co., a London firm, from the space market following the Intelsat loss. Orion had partially underwritten 8 of the 10 satellites lost in space.[33] Bernard Goudge, manager of Orion's aviation department, indicated that Orion would not reenter the satellite insurance market until there was "a radical re-think" of how satellites should be covered, mentioning as a possible solution the one satellite loss deductible.[34]

Events since the loss of the Intelsat have been more positive. There were no further losses in 1984. The industry also received some good news when RCA's claim for its loss of the transponders on its Satcom F2 satellite in 1983 was reduced from $20 million to $9 million.[35] Even more important was the successful retrieval of the Westar and Palapa satellites by the STS 51-A shuttle crew in November, following the successful launch of two other satellites. The November flight completed the third successful use of the PAM boosters which were responsible for the loss of the Westar and Palapa satellites in February, demonstrating that they had been successfully fixed.

The successful salvage operation should help the cash situation of the companies involved. The underwriters paid Hughes Aircraft $5 million to provide salvage equipment and paid NASA $5.5 million for the retrieval effort. The satellites might sell for $25 to $40 million each.[36] The net return would, of course, still be a small fraction of the losses sustained.

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[30] Business Insurance. "Coverage Changes Loom for Satellites." June 6, 1984, p. 86.

[31] Ibid., p. 26.

[32] Aviation Week and Space Technology. "Loss of Satcoms Affecting Industry." June 25, 1984, p. 87.

[33] Washington Business. June 25, 1984, p. 29.

[34] Business Insurance. "Large Satellite Underwriter Withdraws From Marketplace." July 2, 1984, p. 1.

[35] Ibid., p. 8.

[36] James Barrett, president of INTEC, suggested that $25 million was "in the ballpark." Journal of Commerce. "Grapples Viewed Vital for Future Spacecraft." Nov. 19, 1984, p. 7A. Another report suggested that the insurers participating in the rescue effort hoped to sell the satellites for $30 to $40 million each (Journal of Commerce, "Syndicates, NASA Set Satellite Rescue Mission," Oct. 23, 1984, p. D2). Stephen Merrett of Merrett Syndicates, a London underwriter, estimated that Palapa would sell for $20 to $40 million and Westar for $25 to $30 million. Journal of Commerce, "July Slated to Re-Launch 2 Satellites," Nov. 23, 1984. p. 1. On Feb. 8, 1984, Merrett reported that three people were seriously negotiating to buy the satellites and that Palapa would sell for $30 million and Westar for a little less. The net effect of the salvage operation would reduce the $180 million loss to about $130 million (Journal of Commerce, "Three People Negotiating to Buy Rescued Satellites," p. 1).

The success of the retrieval may not have much long-term significance. To begin with, the two satellites were in an orbit accessible by the shuttle. Moreover, Stephen Merrett, of Merrett Syndicates, a leading London underwriter and major participant in the rescue effort, felt future rescue missions were unlikely and that NASA would not charge such a low fee for a rescue operation again.[37] Other insurers have argued that there may be some effect on reducing rates now that NASA's ability to recover lost satellites is proved.[38]

The 1984 losses caused concern about both the level of rates and the availability of coverage. One expert, David Thompson of the Stewart Wrightson Broking Group, noted the withdrawal of firms from the business and characterized the reduction in capacity as the more serious of the problems.[39] James Barrett of INTEC stressed this problem, along with growing concern about multiple launches on the shuttle and the Ariane, which increases total risk from a single accident.[40] Concrete evidence of this problem is the difficulty experienced by the Arab League and the Brazilians in obtaining coverage for the Ariane launch in February 1985. The *Washington Post* reported that Brazil was having difficulty obtaining insurance for its February 8 launch, and the Arab League could not obtain full coverage for its satellite either (the two were launched together).[41] In the same article, Michael Hewins of Johnson & Higgins suggests that new alternatives will involve coinsurance (where the client assumes some of the risk) or satellite deductibles. Industry sources suggested that partial insurance will be the norm for a time.[42] According to James Barrett of INTEC, underwriters will agree to insure only the safer stages of the launch process and satellites will be built to make it easier to recover them.[43] Another effect might be the breakdown of the insurance into more distinct categories, so that, for example, the failure of the PAM booster could be separated from the reliability of other parts of the launch system, whether shuttle or an ELV.

The Economics of Risk and Insurance and Market Failure in the Space Insurance Industry

The major objective of the detailed discussion of the space insurance market in section I was to provide some background to address the issue of whether a market failure exists in the industry. Before considering the specifics of the industry, a brief overview of the economics of risk and insurance will be provided.

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[37] Wall Street Journal. "Shuttle's Deft Retrieval of Errant Satellite Isn't Seen Easing Space-Insurance Rates." Nov. 13, 1984, p. 3.
[38] Underwriter. "Satellite Insurance Remains High Despite Recent Space Recovery." Nov. 30, 1984. p. 1.
[39] Ibid.
[40] Journal of Commerce. "Underwriting Capacity for Satellite Cover Dips." Jan. 14, 1985.
[41] Washington Post. "Costs Climb for Satellite Insurance." Jan. 16, 1985, p. F1.
[42] Ibid.
[43] Ibid. p. F2.

THE BASIC ECONOMICS OF RISK AND INSURANCE

Since risk is pervasive, the economics of risk taking and uncertainty has received considerable attention in the literature.[44] The basic proposition of the economics literture is that individuals are risk averse. That is, individuals prefer a certain outcome to an uncertain one with the same expected value. That is, one would prefer someone to give him a $1 than to offer $2 if one flipped heads on a coin toss. Both have the same expected value, since the probability of obtaining a heads is 50 percent.

Some individual behavior—gambling—is characterized by risk taking, but it is generally presumed that such gambling involves a consumption value and that individuals enjoy the act of gambling. The evidence of risk aversion in general is powerful both in the relative returns earned on securities and the institution of insurance, as well as in basic mathematical theory.[45] Although risk was unavoidable, the market could be used to trade in risk so as to both diminish the amount of risk and allocate it to those most willing to bear it—that is, those who are the least risk averse.

There are certain requirements for a market to yield an efficient solution. The basic principles of insurance are really twofold, therefore.

One effect of insurance is to actually diminish risk by risk pooling. That is, when many identical events are combined together risk is diminished. Betting on a payoff for flipping a heads in 1 coin flip is quite risky; betting on 10 flips is considerably less risky, and betting on 1,000 flips is hardly risky at all. Thus, some types of insurance, such as life and automobile, are hardly risky at all.

In addition, insurance involves buying and selling of risk so that typically risk is spread across many individuals. If a given set of events is risky, the burden of that riskiness is less, given individual risk aversion, if spread across many individuals. Thus insurance relies on both risk pooling and risk spreading. Risk spreading reduces risk and insurance also provides a mechanism for marketing risk to those who are interested in undertaking risk for a return.

There are certain conditions under which markets work efficiently to allocate risk. In order for markets to be efficient, one must be able to assign probabilities to events, and then a market for contingent claims must be present. A market for contingent claims is simply an insurance market so that one can purchase for a fee a claim that restores income in the event an undesirable event (for example, accident, death) occurs.

In practice, perfect insurance markets do not exist. In some cases market failure occurs because the transactions costs are very large. Another reason is the presence of moral hazard, where an individual can influence the outcome by his actions. Moral hazard exists in a pervasive fashion but is clearly more important in some types of markets than others. In may be quite important in health insur-

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[44] Almost any basic enonomics test will review risk and insurance. See for example, Walter Nicholson. "Microeconomic Theory." Hinsdale, Ill.: The Dryden Press, 1978, chapter 6.

[45] The necessity for risk aversion was shown in the St. Petersburg Paradox first investigated by Daniel Bernoulli in the 18th century. The St. Petersburg Paradox was a game constructed with payoffs and probabilities such that the expected value was infinite but one has a 50 percent chance of receiving a small sum, such as a dollar. If individuals were not risk averse, they would be willing to pay all that they owned to play the game.

ance, for example, but relatively less important in life insurance. Even in the case of life insurance, moral hazard can be a problem so that life insurance companies do not pay claims, when they can prove suicide or homicide with the object of collecting the insurance. In health insurance, moral hazard is generally dealt with by deductibles and copayments. One cannot necessarily rule out moral hazard in the case of the satellite insurance industry, although it seems unlikely to be a serious problem.

Another factor which can cause a market failure is imperfect information. The efficient market solution presumes that individuals know and can agree on the probabilities to be assigned to different events. If probabilities cannot be assigned because they are not known (by anyone), then economic theory has very little to say about producing an efficient outcome. Another problem is the possibility of asymmetric information. If the client has information about the probabilities which are not available to the insurers, the market is distorted. Those individuals with a greater probability of the insured event occuring will find the price of insurance below the true fair price and will want to increase their purchases. Individuals with a smaller probability will find the price too high and leave the market or purchase less insurance. The result is absence of an efficient market.

With this background, we can now consider whether or not the space insurance market is subject to these sources of market failure in any considerable degree, which might in turn justify Government intervention.

CHARACTERISTICS OF THE SPACE INSURANCE INDUSTRY

As noted earlier, the major purpose of the detailed chronology of the history of the space insurance industry was to attempt to identify characteristics of the industry which have implications for the potential of market failure which might justify some Government intervention.

Perhaps the most important impression from a reading of the history of space insurance is the impact on the industry of a single loss. Each major loss caused a very perceptible effect on the market in terms of rates, availability, and general attitude. This effect is in dramatic contrast to those insurance markets which work best (such as life insurance) where there is a very large pool of repetitive events and no one event has an effect. The limited number of events is inevitable because of the nature of the field. Furthermore, because of the complex and changing technology of the field, events are not identical and thus probabilities are more difficult to apply.

That such factors make the space insurance business exceptionally risky is argued by reporter Chris Bulloch in *Interavia.* He identifies four factors which contribute to risk: The newness of the field, the complex and changing technology, a limited number of high-value events, and the vulnerability of the system to trivial faults which would not be crippling or even serious in earth bound events.[46]

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[46] Chris Bulloch. "Insuring Spacecraft: How Long Can the Losses Continue?" Interavia, 2, 1984, p. 163.

The fact that the space industry in the aggregate is in a net loss position and has been for some time is merely a symptom of a basic riskiness when the odds turn the wrong way.[47] The result may be a rise in rates which persists and may actually move the market toward more actuarially fair pricing. But the very fact that the industry is in such a position in the aggregate testifies to the limits of risk pooling, which are the basis of insurance, in the space insurance industry.

The significance of single events has also been increased by the multiple payloads on Ariane and the shuttle. While the ability to launch multiple payloads is more efficient, it does magnify the problem of the effects of single losses on the insurance industry, and reduce the number of separate events.

These limitations of risk pooling, as noted earlier, are tied to the complex and evolving technology of the industry. This problem of sophisticated technology leads to another problem. Normal actuarial techniques, already made less reliable because limited events, must be supplemented with assessments of each event based on technological expertise, given the constantly evolving technology. Yet this technological expertise may nevertheless be inadequate to assign reasonable probabilities and it, furthermore, may lead to an asymmetry of information between client and insurer.

There is some evidence that the information problem, and the problem of asymmetry is serious and increasing. Earlier, it was noted that such concerns were expressed following the loss of Insat 1-A in 1982.[48] Similar concerns were expressed following the most recent launch failures.[49] Comments by two other space insurance experts are also suggestive of an increasing concern about information and technology. Brian Stockwell of Corroon & Black Inspace stated, following the Westar and Palapa losses, that technical doubts resulting from these technological changes have to be dealt with. "The questions we are asking are, is the technology for this type of launch into orbit fully mastered, and is there some unacceptable degree of complacency in the program."[50] He also indicated, following the Intelsat launch failure, that the rates would increase for Ariane, too. "The underwriters are going to take the view that nothing is sacred. Everything seems to be able to fail for one reason or another."[51]

Similar concerns were voiced by James Barrett of INTEC. He said that underwriters need to increase their scrutiny of the manufacturing process, noting:

> If we are deprived of the normal practices of insurance, that is to investigate the risk early before committing our-

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[47] NASA Administrator Issac Gillam, however, argued that the turmoil in the industry is partly due to the artificially low rates. Insurance rates for the expendable launch vehicles, for example, the Atlas Centaur which failed to launch the Intelsat in June 1984 should be based on a 90-percent success rate, but customers were being charged about 6 percent rather than 10 percent. (Defense Daily, November 6, 1984, p. 28.) Brian Stockwell of Corroon & Black had made a similar argument earlier, when he said that even prior to the loss of the Westar and Palapa satellites in February 1984, the market was less than health and was hardening. (Aerospace Daily, Mar. 15, 1984, p. 88.)

[48] See footnote 22.

[49] See footnote 30.

[50] Aviation Week and Space Technology. "Rise Seen in Insurance Coverage." Feb. 20, 1984, p. 25.

[51] Defense Daily. "Three Satellite Losses to Boost Insurance." June 20, 1984, p. 279.

> selves to underwrite it, then many underwriters will go away from the class altogether and those that remain will have no alternative than to put the price up extraordinarily high.[52]

Mr. Barrett also argued that the losses would motivate insurers and their financial backers to gain more technical understanding, stating:

> The one absolutely certain thing is that we must differentiate between development satellites and launching systems and those that are tried-and-true in which we have developed an in-orbit experience. * * * The level of evaluation has got to be much higher. The numbers are so great that we can't afford to crap-shoot anymore.[53]

Concerns were also voiced by Eddie Simms, of the Lloyds of London underwriter syndicate, Ariel, who indicated, following the loss of the Westar and Palapa satellites, that insurers will have to alter their way of evaluating space risks. These evaluations had previously been based primarily on the launch vehicle but would now have to also consider the manufacturer of the satellite and the type of equipment used to place the satellite into geostationary orbit.[54]

These and earlier instances of concern about technology suggest that certain market failures including inability to assess probabilities and asymmetric information may exist. This inability to assess probabilities arises from the limited risk-pooling abilities and from changing technology which may prevent even statistical pooling of the relatively small number of launches that do occur. There have also been some suggestions of limitation of risk spreading,[55] and the small number of underwriters involved may reflect the perceived riskiness of the business.

Both statements by individuals in the industry and the swings in the industry resulting from particular launch failures are suggestive of market imperfections. The presence of market imperfections does not necessarily mean that the Government should assume an active role in intervening in the market, but it does suggest that there may be some justification for a Government role, since the market will not at this point achieve a fully efficient outcome on its own.

Consequences of Market Failures in the Space Insurance Industry on the Commercialization of Space

If a serious market failure occurs, it could have important consequences on the commercialization of space. Obviously, such a market imperfection could impede the development of commercial space activities. It could also, however, change the general structure of the developing market in satellite and other commercial space activities by making it more difficult for smaller firms to

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[52] Journal of Commerce. "Space Insurers Recoil from Losses." June 19, 1984, p. 1.
[53] Washington Business. "Risks, Big Losses Persuade Orion to Stop Insuring New Satellites." June 25, 1984, p. 29.
[54] Business Insurance. "Latest Satellite Losses to Propel Rates Upward." Feb. 13, 1984. p. 8.
[55] See footnote 28.

compete in the industry. In order to assess these effects, this section first considers what type of reactions the industry might have, and then the consequences of these reactions for the business. In the subsequent sections, we consider what role, if any Government might play.

MARKET REACTIONS TO INCREASED RISK

To the extent that market failure occurs in the space insurance industry, some of the consequences if the industry is left to react on its own have already been discussed. The possibility of raising rates is quite real, but at least this effect would still make insurance available—at some price. Such an outcome could make all commercial space endeavors more costly and might delay the commercialization of space.

Other options as mentioned earlier include the deductibles, including the one satellite deductible, or coinsurance where only a percentage of the cost would be insured. These types of options might be an expected response to certain types of market failures including moral hazard and asymmetric information leading to adverse selection of poorer risks in the insurance pool. They might also be a symptom of unwillingness to take risks by the underwriters because probabilities cannot be reasonably judged.

Another possibility is that insurance may simply be unavailable in some cases either for certain types of launches or for only part of a multisatellite launch. In this case, firms would have to self-insure (bear the risk themselves). Self-insurance may be a viable option for some large firms and governments but may not be possible for small firms, particularly if financing of investment by borrowed funds includes a requirement of insurance.

One option which has been discussed is for satellite owners to form a self-insurance pool.[56] For example, eight satellites could be combined with each owner providing a letter of credit worth one satellite (12.5 percent of the total value of all satellites on average). If a failure occurred, the letters of credit would be called in for payment. The pool could then purchase an insurance policy for second and third losses. The rates should be much cheaper for these policies. (The odds of two failures would be much less than the odds for one. If there is a 10-percent chance of the loss of one satellite there is only a $(0.1)^2$ or 1-percent chance of two satellites being lost and a $(0.1)^3$ or one-tenth of 1-percent chance of three satellites failing.)

There are some potential problems associated with the pool. One problem is that risk may vary among the different launches and some method of compensating for that risk would required. This is a problem of information and probability assignment which would not disappear.[57]

Another reaction which has already taken place in the insurance market is that insurance for future launches, say more than a year in the future, are not available.[58] This market failure may arise

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[56] Communications Daily. "Inspace and Satellite Owners Discuss Self-Insurance Pool." Dec. 21, 1984, p. 3.

[57] Ibid.

[58] This point was noted by Jerome Simonoff of Citicorp. Aviation Week and Space Technology. "Loss of Satcoms Affecting Insurance." June 25, 1984, p. 87.

from uncertainty about future technology and the unwillingness to commit large amounts of funds given the riskiness of the market. As noted subsequently, it has some consequences for the commercialization of space.

CONSEQUENCES OF THE CHANGES IN THE SPACE INSURANCE INDUSTRY

The increased rates and other risks would, of course, cause changes in relative prices which would be expected to slow the development and reduce the ultimate size of the commercial space industry, at least until technology becomes more stabilized. In most cases these increased costs and risks can be passed on to the final consumer through higher costs. Of perhaps somewhat greater concern are the potential effects on the emerging new industries, such as materials processing in space. These industries are already highly risky, and increased risk of placing space objects into orbit may deter their development considerably.

Concern about emerging industries has been expressed by Jerome Simonoff of Citicorp. As noted above one problem with the insurance market is a reluctance to provide insurance for future launches (more than a year into the future). He noted:

> The reluctance to enter into longer term future commitments does not seriously impede financing of today's communications satellites. However, applications involving multiple uses such as in-space manufacturing, could have funding availability problems.[59]

Another of the consequences of the market responses mentioned earlier is the potential impact on smaller firms. In general, the effects would be most severe for small firms. Whether the problem is rates that may be too high, increasing the risk to the owners through deductibles and coinsurance, or simply not providing coverage, small firms will be most heavily affected because they do not have the option of self insurance. Self insurance works best for those firms that plan to launch a number of objects. The same probabilities noted above will apply in that the probabilities of having two failures out of a series are tremendously smaller than the probability of having one. There may also be a practical constraint. Firms that borrow money or receive other financing which requires insurance coverage cannot operate unless insurance is available at rates which are somewhat reflective of true loss expectations.

An additional concern is that the fluctations in the market can have more severe consequences for small firms than for large ones. Uncertainty about the price and availability of insurance poses a much greater riskiness to small firms with no self-insurance options. When one is considering small firms involved in the more risky aspects of space commercialization, the contribution of any market in insurance could pose a substantial barrier to the participation of smaller firms in the developing segments of the market.

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[59] Ibid.

Government Involvement in Insurance

In considering what role Government might play in the space insurance area it is useful to consider what role the Government has played in the past. This section examines the role of Government in other areas of insurance and provides background for considering the issue of Government involvement.

Government, both State and Federal, is involved with insurance matters as regulator/supervisor of the business of insurance and as provider of certain insurance coverages. This section will comment on the system of insurance regulation practiced in the United States, identify the universe of Government insurance programs, and discuss Government use of insurance programs and concepts to achieve certain economic ends.

THE REGULATION OF INSURANCE

The regulation of insurance has, in the United States, been a function of the States rather than the Federal Government. The insurance industry remains the only large-scale financial service sector which, unlike, for example, the banking industry or securities markets, is not directly regulated by the Federal Government. The U.S. system of insurance regulation evolved from a legacy of early State regulatory activities and, either as cause or effect, insurance development and thinking has been primarily geared to a State-by-State approach. The United States is atypical in that it does not supervise its insurance industry at the national level. As a result, the quality of State insurance regulation has been characterized as uneven and the coordination of interstate regulatory activities can present serious problems. The multiplicity of State insurance codes have the distinct disadvantage of lacking uniformity.

Critics of State regulation emphasize the duplication, complexity, and inefficiency that may result from nonuniformity. From its beginnings, State insurance regulation has developed into a complex institution with strong vested interests. Insurers have, by and large, learned to live with the existing system and have shown distaste for change in regulatory patterns.

The McCarran-Ferguson Act of 1945 (Public Law 79-15, 59 Stat. 33, 15 U.S.C. 1011-1015), exempted "the business of insurance" from Federal antitrust laws and continued traditional State insurance regulatory authority. The act also implies oversight responsibility on the part of the Congress to assess periodically the adequacy and effectiveness of State regulation and to legislate necessary reforms or require the States to do so.

The U.S. system of insurance regulation may puzzle foreign observers. A European is accustomed to consider the free movement of trade and commercial services as one of the prime responsibilities of a central government and the existence of uniform legal rules for large-scale business operations as an essential condition for that free movement.

In recent years, a number of insurance issues and problems have emerged on the national scene. Some of these issues are related to the operation of insurance markets and concern problems of availability and affordability of certain insurance coverages. This situation has prompted the Congress to take an increasing interest in

the efficacy of State insurance regulation. Congressional interest has set in motion considerable legislative activity in insurance related matters and has resulted in extensive hearings and various legislative initiatives. While this activity has prompted some changes in the conduct of the insurance industry and has encouraged States to exercise more conscientious regulation, it has not caused any fundamental changes to occur in the structure of insurance regulation in the United States.

In the future, change may be thrust upon the industry and State regulators alike as the Congress comes to grips with the public policy implications of the restructuring of U.S. capital markets. One issue in particular, is how to reconcile a traditionally State-regulated industry, like insurance, with the federally regulated banking and securities industries. Much change in the marketplace is technology driven. Rapidly evolving computer and communications capabilities for information storage, manipulation, and transfer have raised a host of regulatory challenges for Government.

The existing system of insurance regulation has not had an adverse effect upon the market for space insurance primarily because coverage has been organized by large international insurance brokerage operations and placed in the London market or with large insurance carriers in the United States. Approval of rates and forms has not been a factor as each separate space initiative has required policies custom tailored to provide for the risk exposures involved.

To date, apparently no insurer of space risks has failed to pay his share of legitimate claims. Regulatory problems could emerge as the space insurance market matures and particularly if the commercialization of space were to spawn a competitive market drawing in smaller insurance companies that lack the underwriting sophistication and financial resources of the present limited market.

JUSTIFICATION FOR GOVERNMENT INSURANCE OPERATIONS

There appears to be ample evidence that the private insurance mechanism is unable to serve all practical needs for insurance and that market difficulties affecting the supply of insurance is a persistent problem in some classes of business. Private insurance companies are not philanthropic institutions. The private market will operate to provide specific types of coverage only if insurers can underwrite risk exposure profitably.

For most forms of insurance, the marginal, poorer quality risks are winnowed out in the selection process by restrictive underwriting rules or, if accepted, are priced at rates that few could reasonably afford. This practice has been described by its critics as adverse to the public interest but is defended as rational economic conduct for sound insurer profit management.

Some degree of cross-subsidization among varying classes of risk exists, in part of because of the Government presence. A fundamental tension in the insurance business is to what extent preferred classes of business should be assessed higher than actuarially necessary premiums to subsidize the rate structure for marginal risk within an overall competitive environment?

Sound economic decisions by insurance company managers argue for the elimination of unprofitable classes of business. This can be accomplished by refusal to underwrite initially, cancellation during the policy term, nonrenewal upon expiration, or by setting rates at unaffordable levels, whereby insurers effectively price themselves out of the market. A competitive market exists for the better classes of risk but problems of affordability and availability of coverage persist for many risk exposures. Market operation can entail sometimes rapid expansion and contraction of insurance capacity because of favorable or unfavorable loss experience, or even the perception that gains or losses may be imminent.

The principal contribution of Government insurance programs has been to provide coverages that commercial market insurers are unwilling or unable to offer. As a rule, governmental insurance programs do not compete directly with products offered by insurers in the private sector. For the most part, governmental insurance operations have been justified on the grounds that private insurers consider certain loss exposures commercially uninsurable and have been unwilling or unable to provide forms of protection considered necessary by Government for the public welfare. Government-subsidized programs can offer various insurance coverages without operating under the rigid actuarial principles that private insurers must follow. It has been charged that unless actuarial principles are adhered to, protections provided are not insurance and the agencies of Government offering it are not insurers. The beneficiaries of Government insurance programs, however, are not concerned with semantics and commercial insurers are, in general, content not to be compelled by Government to provide forms of insurance protection that they could not profitably underwrite.

GOVERNMENT INSURANCE

The Federal Government has, over time, engaged in various federally sponsored insurance activities; however, its involvement in the "business of insurance" has, in general, been limited. Federal insurance programs, as a rule, do not compete directly in the marketplace with products offered by insurers in the private sector.

Government insurance is written by both Federal and State agencies and may be voluntary or compulsory in nature.

Compulsory Government insurance

Government insurance coverage that helps to provide economic security for the well-being of the populace is generally referred to as "social insurance" and is written by Federal and State Governments. The Federal social insurance program (Social Security) offers income protection for qualified survivors of deceased covered workers, disability and retirement income coverage for qualified workers and their dependents, and medical care coverage for qualified persons upon attaining age 65. Another form of compulsory Federal protection is pension termination insurance.

State-administered social insurance plans include State worker's compensation, unemployment, and nonoccupational disability income plans. Worker's compensation insurance is required in most States although in many States it can be written by private insur-

ers. Six States operate monopolistic State funds for worker's compensation. Twelve States operate worker's compensation funds that compete with private insurance. Compulsory nonoccupational health insurance is required in five States and in Puerto Rico.

Voluntary Government insurance

Voluntary Federal insurance plans include crop insurance, bank deposit insurance, savings and loan insurance, military personnel life insurance, securities investor protection insurance, crime insurance, mortgage and property improvement loan insurance, supplemental medicare, insurance against foreign expropriation of a limited class of U.S.-owned companies, and programs for flood losses and surety bonding for minority contractors. State-operated voluntary plans include hail and life (Wisconsin), title and auto (Maryland), and medical malpractice. A few States have a voluntary system of worker's compensation.

Summary of Federal and State Government insurance programs

—The Federal Crop Insurance Corporation [FCIC], which offers insurance against crop failures resulting from perils of nature.
—The Department of Health and Human Services offers coverage for death, disability, medical care, and old age through the Social Security Administration's OAHSDI.
—The Veterans' Administration offers life and disability insurance to members and veterans of the Armed Forces.
—The Federal Deposit Insurance Corporation [FDIC] provides bank deposit security.
—The Federal Savings and Loan Insurance Corporation [FSLIC] protects savings accounts in Federal savings and loan associations and in State-chartered thrifts and home-financing institutions.
—Mortgage and property improvement loan insurance programs provide mortgage insurance to aid both urban and rural homebuyers and mortgage lenders.
—The Securities Investor Protection Corporation [SIPC] protects customer's securities held by registered broker-dealers up to $100,000.
—The National Credit Union Administration insures credit union accounts.
—The Federal Insurance Administration operating under the aegis of the Federal Emergency Management Agency [FEMA] has provided insurance programs for floods, crime, and riots.
—The Overseas Investment Group, composed of a group of private insurers and the U.S. Government's Overseas Private Investment Corporation [OPIC], provides coverage for private American investment against foreign political risks of expropriation and currency inconvertibility.
—The Maritime Administration of the Department of Transportation has, since 1952, operated a marine war risk insurance program. The program insures operators and seamen against losses resulting from war or warlike actions during periods when commerical insurance is not available on reasonable terms and conditions. The program provides several specific types of coverages and is financed through the war risk insur-

ance revolving fund. The fund receives income from finder fees, premiums, interest on investments, and other sources. Insurance claims and overhead fees and expenses are paid from the fund.

—The Federal Aviation Administration operates an aviation war risk program that allows commercial air carriers to operate internationally in situations where private insurance is not available on reasonable terms and conditions and where the president has determined that continued operations serve the U.S. national interest.

The State governments also provide various insurance programs. Among the programs are hail insurance, worker's compensation, unemployment, nonoccupational temporary disability income insurance, title insurance, auto insurance, and life insurance. Every State does not have all of these programs.[60]

The list of Government insurance-related activities may appear extensive, particularly when broad-scale social insurance programs are included. The impact of Government programs on the private commercial insurance market is, however, not great in most areas. The operations and rates of most markets are not to any significant degree influenced by Government insurance programs, although there are obvious exceptions, such as social insurance.

NOTES ON LIABILITY, THE PRICE ANDERSON ACT, AND THE FEDERAL FLOOD INSURANCE PROGRAM

A significant way that Government has employed insurance concepts to achieve economic ends is in setting limits on potential levels of liability. There are historical precedents for Government's control of liability and NASA has already acted to deal with some of the liability contingencies of the space shuttle program. Liability exposure in terms of financial responsibility for accidents involving the risk of considerable loss of human life, as might be the case with hazardous earthbound industrial activity, does not at this time apply to insuring commercial space initiatives. The concept of liability combines a legal element and an insurance element. The legal element involves the traditional right, under tort liability law, to sue for recovery of all damages to an individual and his property that result from the carelessness or negligence of another party. These damages, for which the at-fault party is liable, can include personal injury, property damage, economic loss, general damages (pain and suffering), and punitive damages.

The insurance element involves financial protection from judgments of responsibility or liability for damages to others. Liability insurance policies do not provide coverage for unlimited amounts. All liability policies have clauses which limit the liability of the insurer. In the event of an accident involving a nuclear-power-generating facility, for example, the total amount of damages could be astronomical. The private insurance industry contends that a full liability insurance program for nuclear accidents would not have been possible because the risk of billion-dollar claims, even though

[60] Only Maryland has an auto fund and Wisconsin a life insurance fund. Puerto Rico has a territorially operated no-fault auto insurance system.

remote, would have forced insurance companies to charge prohibitively expensive premiums. Without insurance or a substitute form of guarantee that they would not be held accountable for huge claims, the utilities would not have risked undertaking the development of a nuclear power industry.

In order to encourage the development of a private nuclear power industry, the Congress, through the Price-Anderson Act of 1957,[61] established a liability limit or ceiling on claims resulting from any one accident. As long as liability is limited, total protection, as afforded by the right to sue for all inclusive, unlimited damages, remains incomplete.

The Price-Anderson Act was designed to be an excess coverage indemnity statute. This means that the Federal Government's role as a risk bearer would come into play only if the layers of insurance coverage provided by private insurers and by contributions from an industry assessment fund were fully used to pay claims. The Federal Government would indemnify losses above the combination of these layers up to a ceiling of $560 million. Because of the number of nuclear plants now online, the Government's exposure has diminished considerably.

The Federal Government's willingness to contribute additional indemnification substantially exceeding the layers of coverage provided by private insurers and statutorily limiting of licensees' total liability to $560 million for each accident has had an incalculable stimulative effect on the development of nuclear power. Clearly, no private utility could afford adequate unsubsidized liability coverage for losses in the billion-dollar range. The commerical insurance industry also does not have the capacity to provide such a high level of coverage. Without the Federal Government's indemnification capacity and limit on liability, the private nuclear power generation industry might not have developed at all.

The significance of the Price-Anderson Act is the Government's use of insurance processes to encourage development of a nascent industy deemed worthy of assistance.

Government has, on other occasions, acted to limit liability to encourage the development of industries deemed vital to the national interest. For example, State workmen's compensation laws, that put a scheduled or dollar value on compensation for specific types of work-related injuries, had a considerable stimulative effect on the development of hazardous industries, like mining, and particularly the Nation's railroads.

For many years, the private insurance industry debated the insurability of flood-hazard exposure. The prevailing belief within the industry held that flood exposure was commercially uninsurable. The principal reasons given were: (1) the catastrophic extent of losses, and (2) adverse selection—the tendency of only those persons living in flood-prone areas to purchase flood insurance while those nonhazardous areas would not, thus concentrating risk rather than spreading it over a broad spectrum. Consequently, flood insurance was not generally available in the private insurance market.

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[61] 42 U.S.C. 2210, as amended.

The National Flood Insurance Act of 1968 (title XII of the Housing and Urban Development Act, Public Law 90–448), provided a Federal premium subsidy for flood insurance and established the Federal flood insurance program. The original enabling legislation required State and local governments to adopt land use and control measures to minimize flood damage before they could qualify for participation in the flood insurance program. Congress amended the program in 1969 (Public Law 91–152) to include mud slides and to provide a community judged to have flood-hazard risk with an immediate emergency procedure for protection before the lengthy process of compliance with full program requirements could be completed. Under the emergency program, communities for which necessary actuarial rate and flood hazard elevation studies have not yet been completed, but that adopt minimum flood plain management requirements, are allowed to secure a basic level of flood insurance coverage.

The flood insurance program has been broadened and modified in succeding years, and it presently provides coverage to many types of residences and businesses. The Federal Government initially encouraged and later virtually compelled participation in the program by flood-prone communities. It did this primarily because of economic considerations. Federally subsidized flood insurance is theoretically less costly than low-interest loans and massive general disaster relief made available to owners of homes and small businesses after a flood disaster.

In the long run, the Federal Government would prefer that private insurers assume a role in the risk bearing and administrative responsibilities of the National Flood Insurance Program. The Government has largely completed identification of flood-prone communities and performed the studies necessary to determine degrees of risk within these communities, so that actuarial rates can be applied to the property of those persons choosing to live in known flood-prone areas. The Government has begun a marketing effort that utilizes the vast marketing resources of private insurers and allows flood coverage to be sold as an addition to homeowners insurance. Ultimately, the viability of the flood insurance program depends upon a successful marketing effort that would spread the risk of flood losses across a large enough proportion of those living in identified flood hazard areas so that premiums can be kept at affordable levels without requiring continued large-scale Government subsidization.

Substantially expanded sales of flood policies could have a stabilizing effort on rates even though communities identified as flood-hazard areas are all potentially vulnerable to loss. Only a limited number of these communities will actually experience flood losses in any given year.

The significance of the flood insurance program is that the Government has performed a task that the private insurance industry could not. The Government has identified thousands of communities in riverine and coastal areas that are vulnerable to flooding. Within these communities, Government-supervised studies have been conducted to determine varying degrees of risk in order that actuarial rates could be established. Tough flood plain management

provisions of the program also are controlling development in flood-prone areas.

The Government has set the stage for private insurers to become involved as risk bearers and has already involved them as marketers of flood policies. The long-range goal is to phase out Government participation in the insurance program altogether. The flood plain management aspects of the flood program will probably remain a Federal responsibility to ensure uniform and consistent standards, operations, and enforcement practices.

SPACE RISK CONSIDERATIONS

Under the traditional tort liability system the legal concept of liability protects all persons who are not a parties to a NASA launch agreement against personal injury or property damage in the event of an accident wherein the launch vehicle or its payload were to cause damage to a third party.

Also under the 1967 Outer Space Treaty [62] and 1972 Liability Convention,[63] the United States, as a "launching state," would be liable for damages caused by any object it launches to any citizen of a country that is a party to these international agreements. The agreements created new rules of liability in addition to those of conventional law.

To provide for liability contingencies, NASA has required that all commercial users of NASA's launch vehicles obtain at least $500 million of third-party liability coverage.

The advent of the space shuttle, with its capacity for multiple payloads provided dramatic economics of scale with respect to eliminating the necessity for multiple launches and by providing a cargo area large enough for multiple use including scientific experimentation and manufacturing, in addition to satellite launch capacity. The multiple payloads and the personnel required to service them, however, created a liability question that was considerably more complex. The failure of malfunction of any one part of such a payload could result in the loss, damage to, or loss of function of other separate components of the mission.

The problems involved with attempting to adjust claims or determine fault in the traditional manner are obvious. To control this liability problem NASA requires all parties in a multiple payload shuttle launch to sign agreements waiving liability rights for damage to property carried on the shuttle and for damage to the shuttle itself.

NASA's general counsel developed an extended cross-waiver of liability for all participants on the space shuttle project. In effect each party assumes damages for its own property and holds no other responsible for damages, so no one can be held liable under any theory of liability. The waiver clause is to be incorporated in all future contracts involving the shuttle.[64]

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[62] The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies. Jan. 27, 1967. 18 U.S.T. 2410, T.I.A.S. 6347, 510 UNTS 205.

[63] Convention on International Liability for Damage Caused by Space Objects. Mar. 29, 1972. 24 U.S.T. 2389, T.I.A.S. 7762.

[64] Business Insurance. "NASA Asks Reagan to Extend Indemnifications to Contractors." Oct. 25, 1982, p. 60.

The requirement that each shuttle user carry a $500 million liability insurance policy resulted in a classic "capacity crunch" in the space insurance market. According to Neil Hosenball, NASA general counsel:

> If you have two or three people flying payloads together, there may not be enough capacity in the market for liability insurance. The market can provide $1 billion but not much more. So the third person looking for liability insurance in the market probably couldn't get coverage.[65]

Other space insurance industry specialists contend that $1 billion in liability insurance is "far beyond the capacity of the underwriting community." [66]

NASA is now operating under a policy that limits the total liability requirement for multiple users of the shuttle. Total third-party liability protection cannot now be in excess of $1 billion.

NASA has also arranged for INTEC to establish a third-party liability facility for each shuttle launch. INTEC would act as an underwriter and provide a $750 million third-party liability policy for each shuttle mission. Mission participants, regardless of size, can participate in the policy.[67] Shuttle users are also free to arrange their own coverage in the commercial market.

Yet another example of Government use of insurance techniques involves an existing executive order, E.O. 19789, with the force of law, that allows Federal agencies to indemnify (pay only for the losses of) U.S. contractors if the activity involved is unusually hazardous and involves national defense. NASA contractors working on the space shuttle were originally considered to be exempted from this protection because the shuttle was not then considered to be an unusually hazardous operation and commercial use of the shuttle was not considered to facilitate national defense.

NASA at first sought an amendment to the Executive order that would include space-related activities but then found that they could include shuttle contractors in the indemnity protection by reinterpreting the qualifying requirements of the original Executive order.[68]

Because future commercial space initiatives may well be conducted from manned space stations, insurance products or techniques will need to be developed that can manage the potential liability contingencies of human error or negligence including the loss of life of highly trained personnel. The liability control techniques employed by NASA in the shuttle program will probably be a model for dealing with similar risk exposures evident in the operation of manned space stations.

Each launch and mission have been unique and, as such, have required that underwriters and brokers design special manuscript policy contracts for coverage to apply to the separate phase of the

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[65] Ibid.

[66] Shearson Lehman/American Express report, p. 6.

[67] Ibid.

[68] When coverage for third-party risks began to present problems in 1979 NASA went to Congress and with administration support was able to obtain legislation that became section 308 of the Space Act (Public Law 96-48). This legislation enabled NASA to insure or indemnify third-party liability re-requirements of its customers.

total operation. There is no standardized policy format. This lack of standardization in policy and form will not doubt continue to apply to any nascent space commercialization enterprise. Sophisticated underwriting will continue to be required, but a potential problem that might result from a complete reliance on the private insurance market is that these insurers may be inclined to insure only the safer aspects of an experimental mission. This would leave the newer, smaller, and less well capitalized space entrepreneurs without the requisite insurance protection to survive, as an ongoing commercial enterprise, in the event of a single major loss.

None of the above is intended to assert the Government intervention in the space insurance market is justified, but to illustrate some considerations which might be taken into account. As noted earlier, there are many instances where insurance markets (and all markets) fail to work efficiently. The decision to intervene in a given market depends on how serious the consequences of that market failure are deemed to be.

Policy Options

From its beginnings space insurance, unlike the commercial space industry as a whole, has operated largely as a free market. The market has been extremely sensitive to losses. Highly publicized losses have been followed by substantial contractions of market capacity (the total amount of coverage that insurance underwriters are willing to commit to a specific line or class of business at any one time).

Demand for space insurance, on the other hand, appears to be increasing. Although demand is rising sharply, the supply of underwriting coverage has actually declined due to 6 consecutive years of losing operations for the space insurance industry. Insurance availability problems have become apparent precisely when increased insurance protection is needed to offset the high risks of both newly evolving commercial space applications and continuation of the established satellite communications industry.

Despite dependence on private markets, there have been a number of signs of market failure in the industry. The fluctuations in the market, both as to price and availability, the original and prospective use of extremely large deductibles (such as one satellite in a series), and similar developments are suggestive of an industry which does not operate as most insurance markets do. The consequences of these developments could slow the growth of the commercial space industry and could have particularly adverse effects on smaller and medium-size firms which require insurance coverage to secure loans and, indeed for survival. The eventual effects on the commercial space market would be a smaller, and more concentrated (that is, dominated by large firms) industry. The significant of such developments is, however, difficult to determine.

These market failures appear to derive from the restrictions on risk pooling which relate to the technological complexity and constant change in the industry. Traditional problems of moral hazzard (ability of the insured to affect the outcome), which occur in some insurance areas, do not appear to be a problem. But the possibility of information asymmetry problems does seem to be relevant

and, combined with the limited number of events due to technological change, suggests some market failure.

Market failures are endemic in any economy, but some are more severe than others. The insurance industry in general is likely to be subject to market failure, and, as demonstrated in the previous section, the Government has intervened in numerous cases. A number of these cases relate to some of the problems which appear in the space insurance industry.[69]

The problems in the space insurance industry appear serious enough to warrant consideration, although it appears impossible to quantify these effects. It would appear that NASA and the commercial market have the requisite authority and flexibility to deal with requirements for third-party liability coverages. Whether the Government should play a role in property insurance, as well as liability insurance, is largely judgmental.

If a decision is made that some intervention is desirable, there are several possible forms it might take. The most limited form of intervention might be for the Government to intervene to bridge the information gap between the insurers and the other firms involved. Independent Government engineers might assess phases of technological development and report on technological risks to the industry.

The Government might choose the more active role of subsidizing insurance rates or actually providing insurance. The latter role would be more appropriate to deal with the problem of capacity constraints. The Government could act as a general "insurer of the last resort" to provide insurance when it cannot be provided by the private market at all or provided only at excessively high rates.

Government subsidization or provision of insurance could be targeted in other ways. One option is to provide insurance for multiple payload losses which can have extremely high values that constrain the capacity of the industry. Or the more risky parts of the launch might be covered leaving more reliable segments to be insured privately. Another option would be for the Government to provide insurance for the part which the private market will not insure, such as the deductible or part of a copayment (the share of a loss the firm cannot insure.)

The role of the Government might also be limited by directing it toward certain industries and activities. For example, to the extent that a market failure has a larger impact on smaller firms, Government-provided insurance or subsidies might be limited to these firms. Certain activities might also be targeted. For example, Government-provided insurance might be targeted to the developing, and presumably less technogically certain, areas of the commercial space industry. In addition, as noted earlier, there may be some reason to believe that manufacturing in space may be subject to

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[69] Flood insurance, for example, was associated with potential catastrophic loss and lack of information about risks. The nuclear power industry also involved complex technology and possibilities for large, catastrophic losses. Of course, although there were some similarities between these cases, there were also some major differences. For example, floods and the potential for flooding affects some individuals directly and significantly, while space insurance has direct effects on a small number of businesses and widespread, but probably small, indirect effects on consumers.

particular constraints because of repeated launches which cannot be insured in advance.

If Government involvement is to be considered, the program might logically be administered by NASA, which has the technological expertise to set rates. NASA also has some expertise in the insurance area, due to their association with the space insurance industry and their intervention into the liability area. A separate insurance authority might also be considered.

Any Government intervention in the market might be introduced with an eye to phasing it out and returning the coverage to the private market as is the goal of the flood insurance program. Such a development might become possible as the industry matures further and technology becomes more stable. The potential losses may become smaller with the development of technology to retrieve objects in space. For example, the development of an orbital transfer vehicle which can retrieve satellites from high orbits, and which is reusable might make retrieval of mislaunched or inoperable satellites a standard procedure.

SPACE

Volume 1, Number 2

Summary

The space insurance industry acts as a vital agent in facilitating commercial space activities. Recent satellite losses, including Indonesia's Palapa B2 and Western Union's Westar VI in February, as well as the Intelsat V F-9 loss in June, have raised questions about the continued economic viability of the space insurance industry. Another hardware failure in the near future would lead to a difficult situation as underwriters withdraw and rates rise to unprecedented levels, causing the availability of space insurance to decline sharply precisely when increased coverage is needed to offset the high risks of both newly evolving commercial space ventures and the satellite communications industry.

The successful launch of three new communications satellites during the Shuttle Discovery's maiden flight helped to quiet the fears of brokers and underwriters and increased confidence in the industry. However, these successes do not substantially alter the projected imbalance between insurance supply and demand. The scheduled number of satellite launches during the next five years will be double or triple the number of launches in 1982 and 1983. Although demand is rising sharply, the supply of underwriting coverage has actually declined due to six consecutive years of losing operations for the industry, which resulted in a net loss position of $282 million for the first half of 1984 alone. These losses will probably result in some combination of rising insurance rates.

Since no new policies have been written since the February 1984 satellite losses, it is difficult to predict how much insurance rates will rise. However, rates for the Shuttle could rise to as much as 20% of the insured value of the cargo — almost a 100% increase — while rates for Europe's Ariane launcher will probably run a few percentage points higher. In addition, although some market contraction has taken place as two underwriting firms have withdrawn, the success of the latest Shuttle mission reduces the likelihood of further withdrawals.

Another major satellite loss in the near future, though, could lead to a substantial decline in insurance coverage, forcing some risk coverage away from the underwriting community and on to the participants themselves. Such participants would include the satellite owner, the hardware manufacturer, the user of satellite services, and possibly the government as an "insurer of last resort." The first three may well have to accept some form of self-insurance as part of the price for participating in a very risky field. The government, although extremely reluctant to step into an insuring role, might choose to do so specifically to prevent a collapse of underwriting coverage for commercial space activities. **We believe, though, that the demand for satellite insurance coverage will be sufficiently strong and will drive premiums sufficiently high to attract adequate coverage and that — barring several more catastrophes — it will not be necessary for the industry to resort to any of the more drastic measures mentioned above.**

An Insurance Analyst's View of Space Insurance

Alice L. Cornish is a Vice President of Shearson Lehman/American Express and a runner-up on this year's Institutional Investor "All-America" Insurance Industry Team. Following are Ms. Cornish's thoughts on space satellite insurance and her analysis of the impact that this new opportunity might have on traditional insurance carriers.

The satellite losses in February have caused concern about the availability of obtaining insurance for future launches. Is this the end of space insurance? We do not think so. The history of aviation insurance has shown the initial reluctance of underwriters to accept new, unusual risks, such as the first jumbo jets. Today this type of exposure is no longer viewed as uninsurable. Moreover, the large losses experienced by commercial fleets during the past several years have resulted in substantial rate increases, although capacity is still available. In fact, the most recent renewal period attracted new entrants because of the higher rates. Also, we feel that the ability to obtain salvage as satellite retrieval efforts begin could be an important element in improving the underwriters' loss experience.

Experts predict that by 1990 as much as 75%-90% of predictable losses for all types of insurance will be self-insured in some manner, such as through group captives. As this phenomenon withdraws demand for the financing of these risks by the commercial insurance industry, capacity will have to go elsewhere. We are already seeing that large insurers have turned to new forms of risk assumption through financial guarantee insurance. The risk/reward potential for these new exposures could be large but will provide the industry with new areas of growth.

For the near future it is a bit more difficult to anticipate the insurance market's reaction to the possibility of covering new satellite risks. The property-casualty industry in general is in an uncertain state, caused by huge underwriting losses from common forms of insurance. The willingness of the reinsurance market to accept even normal risks under previous terms and conditions appears questionable as we approach the 1985 treaty renewals. Yet the industry as a whole is in much better financial condition, at least from a surplus standpoint, than it was 10 years ago. As a result, we expect that after a period of time, insurers will look more favorably on coverages for satellites since the prospects for growth in the traditional market are limited.

Government involvement, however, may be necessary at first should aviation underwriters decide that the risks, for now, are too great. This should not permanently exclude the commercial industry. Insurers such as American International Group (AIG) have found that they can reasonably cover political risk exposures, as an example, which had been the exclusive domain of the government. **Because of AIG's recognized skill in underwriting complex risks, we expect it to continue to be a factor in innovative coverages. This will undoubtedly include some participation in space insurance.**

INDUSTRY OVERVIEW

The recent successful deployment of three communications satellites during Shuttle Mission 41-F, two of which employed the McDonnell Douglas Payload Assist Module (PAM) upper stage that failed twice earlier this year, was greeted with relief by the space insurance industry. These successes helped calm insurers who had been greatly concerned since the unsuccessful deployment of two satellites (Indonesia's Palapa B2 and Western Union's Westar VI) in February of this year; they also served to quiet rumors of a possible "collapse" in the availability of underwriting coverage for space insurance, which arose because of the exceptionally large losses on these and other claims. This issue of Space examines the current state of the space insurance industry and, we hope, will provide insights into this vital component of commercial space ventures.

For several years, the term "space insurance" referred primarily to the coverage of communications satellites. Few other space activities to date have had truly commercial components, and the sponsoring party (usually a governmental agency) has not placed insurance for the activity concerned. Recent satellite losses, due to either launch or hardware failure, have raised sufficiently disturbing prospects to cause the availability of insurance coverage to contract precisely when added coverage is needed to offset the high risks of newly evolving commercial space ventures, as well as the expanding market for satellite communications.

To date, the insurance industry has dealt principally with communications satellites requiring geosynchronous orbits, and insurers have had far less experience with new commercial space activities, such as on-orbit manufacturing or remote sensing. Only one noncommunications satellite payload has been commercially insured, the Shuttle Pallet Satellite (SPAS) owned by Messerschmitt-Boelkow-Blohm (MBB), which carried materials science experiments flown on the Shuttle. The industry's initial response to this new set of risks was to group the new activities with the more familiar communications satellites despite exposure to tangibly different hazards. Consequently, attitudes toward communications satellites can apparently affect the availability of insurance for the entire spectrum of future commercial space activities.

The First Policy

The first insurance policy for satellites was written in 1965 to provide prelaunch coverage for Intelsat's "Early Bird" satellite. Insurers were concerned about covering the risks associated with satellites during the launch and on-orbit phases of a mission since insufficient data were available from prior experience to properly assess the risks. However, after the loss of a satellite in 1968, Comsat approached aviation underwriters in an attempt to obtain a "launch insurance" policy covering the failure of its satellites to achieve proper orbit. The policy insured Comsat against the loss of one satellite in a five-launch series, allowing for one launch failure as a deductible.

In the 1970s, privately owned satellites were launched with increasing frequency, and insurers agreed to provide coverage as sufficient data on satellite reliability were amassed, enabling the concomitant risk calculations. In 1980, Corroon & Black/Inspace was formed as the first company dedicated exclusively to the provision of space project insurance. Since then, a variety of other companies have entered the field, offering insurance to private and public clients owning or operating communications satellites.

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The Players

As in other areas of the insurance industry, three major participants are necessary in space insurance: the broker, the underwriter, and the client. The broker negotiates with the party seeking insurance, is responsible for the details of a given contract, and must seek coverage from the underwriter community. The underwriter assumes the actual financial liability for the insurance policy.

- **Brokers**

At present, several large U.S. brokers have taken an interest in space-related activities:

- Alexander & Alexander
- Corroon & Black/Inspace
- Frank B. Hall
- Johnson & Higgins
- Knaush, Hogan & Maurrey
- Marsh & McClennan

The composition of the underwriter community, though, is complicated by the fact that roughly 70% of space insurance is placed with London underwriters. Thus, brokers must be prepared to work with both American and British syndicates, and nearly all U.S. brokers have at least a working relationship with a certified Lloyds broker. Marsh & McClennan owns 100% of C.T. Bowring; Inspace is a partner of Crawley, Warren Ltd.; Alexander & Alexander works with Leslie, Godwin Ltd.; Knaush, Hogan & Maurrey and Frank B. Hall work with Sedgwick & Forbes; and Johnson & Higgins works with Willis, Faber & Dumas Ltd. Johnson & Higgins also has a "handshake relationship" with the French broker, Gras Savoye S.A.

- **Underwriters**

Space underwriters represent several British syndicates and four major U.S. groups. The most active Lloyds syndicates in underwriting space insurance are the Merrett-Dixie Syndicate and the Ariel Syndicate. In the United States, the key groups are:

- U.S. Aviation Insurance Group (USAIG)
- Aviation Office of America
- Lexington Aviation Insurance Group
- International Technology Underwriters (INTEC)

INTEC differs from other underwriters in that it acts as an underwriting manager for approximately 100 reinsurance companies, each of which commits a sum to INTEC for investment. Its role for the underwriting community mirrors that of the broker for the client community: INTEC "holds the pen" for the collective when a policy is written. The advantage of such a system derives from the fact that underwriters are unlikely to have sufficient technical expertise in-house to assess the risk of space systems. INTEC provides that expertise in return for control over use of the funds committed by the collective.

Although U.S. underwriters possess the financial capacity to handle 60%-70% of the total market risk, this group has historically maintained exposure well under that level, leaving most satellite insurance to the London market.

- **Clients**

The space insurance clientele has been composed primarily of large American telecommunications firms, various governments, and a number of quasi-governmental consortia (such as Intelsat), which sell or lease satellite transponders to a variety of users. However, growing demand for satellite communications services, especially for business applications, has substantially increased both the number and variety of companies that have sought to compete in this market, and this phenomenon has resulted in significant growth in proposed satellite launches. In addition, a number of users of satellite services now require coverage in the event of transmission failure, as well as the more traditional launch coverage.

Moreover, as space commerce develops beyond the satellite communications industry, the clientele will diversify further. The SPAS pallet is the first of several new categories of payloads that will require coverage. Fairchild Space Company has already begun negotiations with insurance brokers to write coverage for its Leasecraft free-flying platform, which is expected to begin operations in 1988. Although recent satellite losses have worried space entrepreneurs who will depend on launch systems that have failed in the past, industry experts believe the losses have not yet been sufficient to completely deter entrepreneurs from attempting new ventures. New losses could, of course, cause these participants to reassess their positions.

Space Insurance Policies

Individual payloads differ significantly enough from one another to merit detailed case-by-case technical examination, while client needs exhibit similarly unique characteristics. Thus, no two space insurance policies are identical. Nevertheless, there have evolved generic forms of coverage that meet most of the requirements for a typical satellite communications firm. These are:

1. **Prelaunch Insurance.** Prelaunch insurance covers the payload during the period prior to its launch and generally involves minimal risk. It carries very low rates on the order of 0.01-0.05 cents per $100,000 of satellite value. A satellite owner can obtain coverage for transportation of the satellite from the manufacturer's plant to the launch site. This insurance is often included in the price of the construction contract with the satellite manufacturer.

2. **Launch Insurance.** Launch insurance covers the satellite payload and the launch vehicle from the ignition of the launch system until the initial operation of the satellite on orbit. Policies cover the performance of the launch vehicle, the apogee kick motor, the upper stage vehicle (such as General Dynamics' Centaur for the Atlas expendable launch vehicle [ELV], the McDonnell Douglas PAM, or Boeing's Inertial Upper Stage [IUS] for the Shuttle), and the deployment and initial operation of the satellite.

Historically, rates have varied somewhat from vehicle to vehicle. These differentials are based on the performance history of the vehicle and the reliability of the technology involved. Thus, Ariane launches have been insured at rates up to nine percentage points higher than Shuttle launches because Ariane, as a new vehicle, counted a number of failures among its earlier flights. Delta and Atlas launches, on the other hand, enjoy lower rates because several years of successful operations. The failures of two Shuttle-launched payloads have led to a reduction in the differential between Ariane and the Shuttle.

For its part, Arianespace, the French company that markets launch services on the Ariane vehicle, has treated insurance premiums as one component of a comprehensive service charge to the user. This charge, which includes the cost of launch, insurance, and initial tracking, is held at rates competitive with Shuttle rates, although the insurance or launch charge components may be considerably different. This kind of "package deal" could produce sizable losses for Arianespace if very large insurance differentials require a comparably sized launch price differential to keep package costs constant. The effect of Arianespace's policy on the user of launch services, on the other hand, is to reduce the differential in total expense between use of the Shuttle and of Ariane.

In contrast, NASA self-insures the Space Shuttle, requiring users to insure only the performance of upper stages (such as the PAM), while the expendable launch vehicles (such as the Atlas/Centaur or the Ariane) are covered in total by space insurers. Launch insurance rates, though, are currently in a state of considerable flux as a result of three launch failures in 1984.

3. **Life Insurance.** These policies insure the operational life of satellites and cover loss of fuel, power or transponders. They also indemnify owners for loss of revenue due to a malfunctioning satellite or the replacement cost of a new satellite. Generally, these policies are not paid out until a specified number of transponders have failed; then the policy is paid out incrementally for each inoperative transponder. As a safety factor, satellites are typically equipped with extra transponders to reduce the effect of hardware failure. Rates for this run around 1%-2% of the insured value per year.

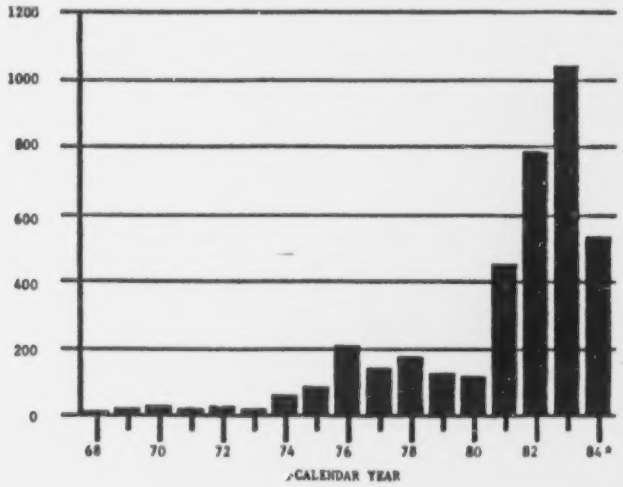
4. **Third-Party Liability Coverage.** Liability coverage is the only policy required by NASA for satellites launched from the Shuttle. An important reason for this is the responsibility of the U.S. government for any damage caused by American space activities, whether sponsored by a government agency or by a private organization, as defined under international law (Article 7 of the Outer Space Treaty of 27 January 1967 and the Liability Convention of 29 March 1972).

Each payload launched in the United States requires $500 million worth of insurance, regardless of the launch vehicle involved. Shuttle launches of multiple payloads would therefore require at least $1 billion in insurance, far beyond the capacity of the underwriting community. For this reason, NASA signed a Memorandum of Understanding with INTEC in 1983, whereby INTEC establishes a third-party liability facility for each Shuttle launch. INTEC acts as an underwriter and provides a $750 million policy for each Shuttle mission. Commercial participants in the mission, regardless of the size and nature of their payload, can participate in the policy. For the typical Delta-class communications satellite (occupying one-quarter to one-third of the payload bay), the premium will be on the order of $100,000-$150,000. Under this policy, payload owners, NASA, and the U.S. government are covered for third-party liability.

Strong Demand

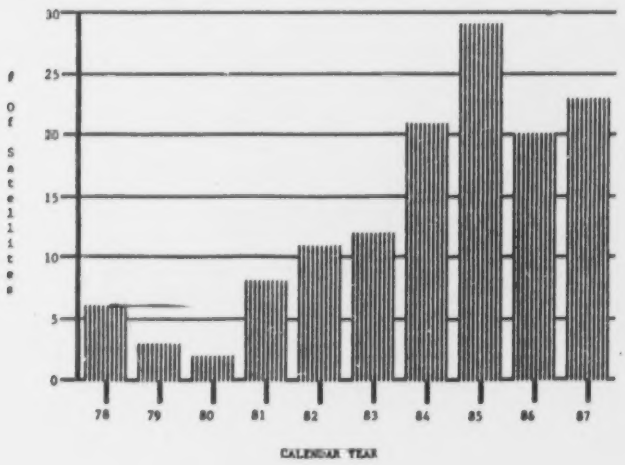
As one can see in Figure 1, the insured satellite launch value has risen sharply since 1968-73. As dramatic as this increase was, though, it is dwarfed by the value of the launches scheduled during the next three years, as shown in Figure 2.

Figure 1: Total Insured Satellite Launch Value, 1968-84* ($ Mil.)



*First half only.
Source: U.S. Aviation Underwriters, Inc.

Figure 2: Insured Satellites Launched Forecast to 1987 (No. of Satellites)

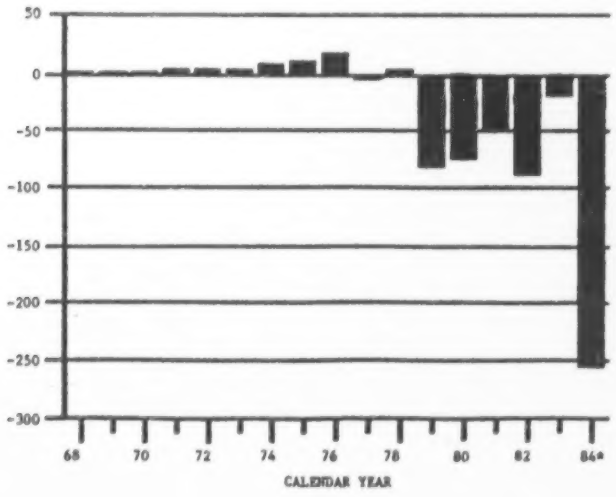


The catalysts for this phenomenon have been economic, technological, and political. In a forthcoming issue of Space, we will discuss satellite economics in greater detail, but the current perception in the marketplace seems to be that the number of usable orbital slots is limited and that the demand for transponder capacity will eventually make orbital slots a scarce resource, even if a glut currently exists. As a consequence, many companies, both old and new, have filed applications with the FCC to launch communications satellites. Due to the long lead times involved and the general lack of flexibility once a company has committed itself, one has a clear picture of what satellite additions could be made for the next several years, and, as shown in Figure 2, the number of satellites scheduled for that time frame is far greater than any prior period. Thus, one could expect that the demand for all forms of insurance discussed earlier would rise proportionately.

SATELLITE LOSSES

Space insurance underwriters ended 1983 in a negative net cash position of approximately $20 million. By February 1984, following Shuttle Flight 41-B, this position had worsened to $180 million because of the loss of the Palapa and Westar satellites. Then, in June the Intelsat V F-9 satellite failed to reach geosynchronous orbit after launch from an Atlas/Centaur ELV and was reported as a total loss. This mishap added a further $102 million to the underwriters' bill. Thus, in the first half of 1984 alone, losses due to launch failures had reached a total of over $282 million.

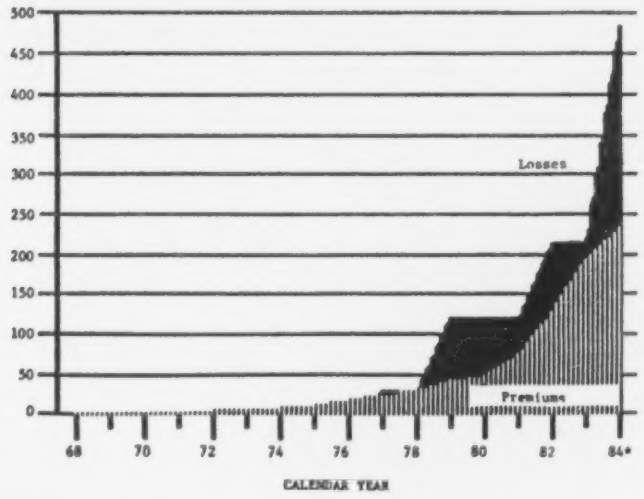
Figure 3: Underwriters' Net Cash Position ($ Mil.)



*First half only.

Shown another way, Figure 4 demonstrates that losses have been substantially greater than net premiums.

Figure 4: Cumulative Net Premiums vs. Losses ($ Mil.)



*First half only.

In addition to these launch losses, hardware subsystems on orbit have caused several satellite failures. Many of these subsystems were not insured, so no claims will be made. Nevertheless, each failure contributes to the overall risk assessment that an insurer will make for a new system. In March an uninsured Japanese direct broadcast satellite lost the use of one transponder and was followed by a second failure in May. In July the environmental satellite NOAA-8 began to tumble and the National Weather Service's GOES-East satellite failed because of a lamp malfunction. Neither government satellite was insured.

More significantly, Intelsat has reported that the maritime communications subsystems on its Intelsat V spacecraft (notably the F-7), which are insured, are malfunctioning. Underwriters have been informed that Intelsat intends to file a Notice of Failure with specific reference to Intelsat V F-7. The launch insurance on this satellite expired 180 days after deployment, but Intelsat claims that the problem occurred while the satellite was still under coverage. To date, no claim has been filed and at this time Intelsat is discussing the anomaly with Ford Aerospace, the satellite manufacturer.

Together, these losses have had a profound effect on the insurance market. No new policies have been written since the Palapa/Westar losses, so it is difficult to determine the full impact on the market as measured by new insurance rates. However, there have been numerous reports of satellite owners finding it difficult

to place insurance. In these cases, the rates discussed were on the order of 20%. The last full insurance program to be placed successfully for a Shuttle launch was in the summer of 1983. Industry observers and underwriters agree that rates for launch insurance will be significantly higher when the next policy is written, although the degree of the increase cannot yet be determined because much will depend on the specific details of the system covered. American brokers and underwriters estimate that rates will climb to somewhere between 15% and 20% for both the Shuttle and Ariane. As a benchmark for comparison, the previous rate for the Shuttle was about 6%, while the rate for Ariane was about 12%. The rate for private U.S. ELV systems could be slightly lower, although the recent Intelsat loss may bring rates to a level commensurate with the other two launch systems.

Rising Rates Probable

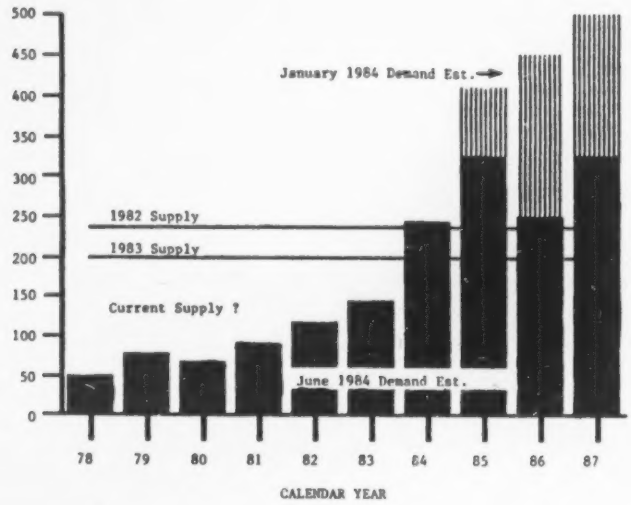
Not only will rates probably rise, but the insurance industry's capacity could decrease. As discussed earlier, 1984 has been a difficult year for the insurance industry, and many of the underwriters covering space accounts have been faced with heavy losses in their aviation accounts as well; this has reduced the amount of funds available for space ventures, and some underwriters have already declined to continue doing business in this area. Among those that have pulled out is London's Orion Insurance Company, which ceased all space-project underwriting in the wake of the Intelsat V F-9 loss. Stewart Smith East, a small ($10 million capacity per satellite per launch) American subsidiary of London's Stewart Wrightson, has also announced its withdrawal from the field, and Lexington's parent firm, American International Group, is reported to be reorganizing its space-related business.

Although no one in the insurance community has taken the losses lightly, some brokers believe that the probable effects of the recent losses may have been overstated. This group contends that the market capacity is unlikely to become constricted because the losses could translate into higher rates, which in turn could attract new underwriters. Perhaps American underwriters who have unused capacity and have been less damaged than their British colleagues by recent losses would find rising rates to be sufficiently attractive to step in and replace foreign withdrawals. Nevertheless, there is broad speculation that another loss this year might "kill the industry" before higher rates could attract new underwriters and reestablish a positive premium base. For this reason, the success of the latest Shuttle mission has been greeted with relief, and each additional success gives more breathing room. However, another loss (on any type of launch vehicle) could disrupt the present tranquility and return the industry to the turmoil of the earlier part of the year. As a result, the insurance industry will be closely following the scheduled launch of shuttle mission 51-A in November, which will include two more commercial satellites.

Supply/Demand Imbalance

Regardless of how the supply/demand balance might be affected by additional losses, as Figure 5 indicates, the demand for coverage could have already exceeded the available supply prior to any of the 1984 losses. What has transpired this year has only exacerbated the previously existing imbalance.

Figure 5: Insurance Supply and Demand Forecast to 1987 ($ Mil.)



Losses Could Be Reduced

The situation may not be all that bad. Shortly after the loss of the Westar VI and Palapa B-2 satellites in February, NASA raised the possibility of retrieving the satellites. The underwriters concerned subsequently negotiated an agreement with Western Union and the Indonesian government to transfer ownership of the two satellites to the underwriting collective after the policies had been paid out. This agreement sets a precedent for future policies and is a first step toward resolving the issues surrounding the value of a "lost" satellite that does not reach its anticipated orbit. Retrieval is now scheduled for Flight 51-A in November. Successful recovery of the satellites could have a significantly calming psychological effect on the market, with beneficial effects on future satellite communications missions.

Satellite recovery inevitably involves a number of components that together may prove to be more of an economic burden than accepting a loss on the spacecraft and obtaining a replacement. The first component is the retrieval itself. Although the actual cost of such a mission is unknown, NASA has informed underwriters that it would charge $4.8 million to retrieve one of the two satellites lost in February and $5.5 million for both. The space insurance underwriters have chosen to retrieve both satellites and have paid NASA the full $5.5 million fee in advance.

If the satellites are retrieved successfully, they will then have to be examined in order to determine whether they should be reconfigured and relaunched, or whether damage is extensive enough to warrant scrapping the spacecraft altogether. Based on

the precedent of the Palapa/Westar negotiations, it appears likely that in the future, title to a satellite will pass to the underwriters if the original owners are paid out. A satellite will be judged worth reusing once repair and relaunch costs (as well as the retrieval costs mentioned above) have been weighed against construction and launch costs for a new satellite (which presumably would also entail a considerably longer downtime before it could be placed in service to begin generating revenues).

One question not yet resolved is the value of a "used" satellite that the underwriter-owner would attempt to sell to a new owner (or possibly resell to the original owner). In the case of scrapping the satellite, the underwriter-owner would hope to recoup some of its losses by selling satellite components as scrap, similar to the method used in other areas, such as shipping. However, neither the scrap value nor the market for used satellites can be predicted at present. Nevertheless, both Pakistan and Thailand have shown an interest in buying the used Palapa spacecraft. Less interest has been shown in the Westar satellite. Part of the difference in enthusiasm could be due to the difference in relaunch costs. NASA could relaunch the Palapa spacecraft by mid 1985 for about $10 million. Westar, on the other hand, is not expected to be relaunched until 1986 due to lengthier refurbishment and will fall under NASA's proposed new pricing policy. Under the new policy, a launch would cost $18-$19 million.

What's the Impact?

The immediate practical impact of satellite retrieval is difficult to gauge. With regard to the communications satellite industry, it is important to note that it will not be possible to recover communications satellites on any regular basis, because geosynchronous orbit will not be accessible to the Shuttle for several years. The upper stage problems associated with Palapa and Westar happened to place the spacecraft in accessible orbits, but they could easily have made them entirely unreachable. Thus, some observers caution that the only long-term effect of the rescue mission is to introduce language concerning satellite ownership and salvage rights into future space insurance policies.

Industry representatives note that although the on-orbit recovery of satellites may not have any immediate effect on the insurance market, their successful reconfiguration and relaunch could have a settling effect on underwriters and could possibly lead to lower rates if underwriters expect to recover a significant portion of their paid losses.

Setting Precedents

Subrogation of ownership rights is a precedent now for accessible satellites and in the future for geosynchronous satellites. Insurance policies in the past have never contained clauses pertaining to ownership of the spacecraft after the policies have been paid out. Although this cannot yet be considered a trend, both underwriters and clients can be expected to make new demands regarding recovery of a malfunctioning or misplaced satellite in the writing of future insurance policies. The unique capabilities of the Shuttle to perform rescue and servicing of errant satellites may give brokers leverage in negotiating lower premiums for clients.

History also provides some precedent for believing that the current furor over rates will subside relatively quickly. The 1979 loss of the Satcom III satellite raised launch rates to about 12%. However, after only one year, the rates had fallen back to 7%.

Finally, NASA is currently offering retrieval rates that are probably well below the actual cost of retrieval, making the economics of retrieval and relaunch more attractive.

ALTERNATIVES TO STATUS QUO INSURANCE

Should another major loss occur in the near future, alternatives to the present insurance industry structure would probably be necessary to diversify risk further than is currently being done — a substantial rise in premiums notwithstanding. Without such a loss, rates could rise enough to assure the stability of the current market structure, although questions remain as to whether underwriting capacity will be able to keep pace with projected satellite launch demand. Even without further losses, though, creative insurance schemes, such as those outlined below, might be necessary to assure adequate coverage for projected demand.

New Approaches

Assuming another loss, rates could be expected to rise substantially, and if underwriting capacity simultaneously fled from the market (as was the case after the recent losses), the situation could become critical. A simple rise in rates will make it more expensive for a commercial operator to obtain insurance — but not impossible to do so. As some underwriters have pointed out, if a rise in rates is sufficient to drive a would-be commercial venture from the field, the project probably should not have been proposed in the first place.

A more serious consequence would be a constriction of the market itself, whether alone or in combination with rate increases. In this case, even those ventures that are commercially viable and prepared to meet the risks involved may be unable to place insurance. If the underwriting community will not accept the risk of space projects, someone else will have to do so instead or commercial space endeavors will fail to materialize.

There are several alternatives to the traditional modes of coverage. Others could step in to help spread the risk: the government, the hardware manufacturer, the satellite owner, and the satellite user (businesses, broadcasters, telephone companies, and so forth). Although a very wide spectrum of scenarios can be described, depending on the nature, timing, and import of a given potential loss, it appears likely that risk could be accepted by some combination of these institutions.

The government could fill the position of "insurer of last resort" as a means of supporting broader space policy goals, until the underwriting community resumes its insuring role. The hardware manufacturer could assume some risk as a marketing tool, since a decline in insurance availability might negatively affect hardware sales. Finally, the satellite owner may have to self-insure and assume a considerable amount of risk in-house.

Co-Insurance

Conservative options include co-insurance and higher deductibles for failure and would transfer some risk from the underwriter to the satellite owner and possibly the manufacturer and user as well. Co-insurance may evolve out of the next series of quoted rates and be implemented without further losses this year. A co-insurance policy could be written such that the owner of the spacecraft would be indemnified for only a percentage of the payload. If the launch were unsuccessful, both the underwriters and owners would lose, giving both parties a more equal stake in the success of the launch. Higher deductibles for failure of a satellite launch work on

the same principle. A co-insurance policy could also be drafted to make the manufacturer of the failed hardware liable for losses and to require the end user of the satellite services to absorb some risk as well.

Self-Insurance

A more radical alternative would be the transfer of all risk to the owner. The risks of this self-insurance alternative are monumental in terms of the possible losses associated with the cost of a satellite, launch costs, and revenue stream. A contingent spacecraft (or ground spare) and funds for another launch would have to be kept in reserve. Such action freezes several hundred million dollars that could otherwise be used for productive purposes. Although established satellite firms, such as Hughes Communications or RCA, might be willing and able to take such a risk, a start-up firm is unlikely to have sufficient resources without the backing of another large firm (possibly including financial institutions), probably through equity arrangements, and it could not survive a self-insured loss on its own.

Utilizing a captive insurance company is an alternative method of self-insuring open to large players if the frequency of launch justifies the costs of setting up a subsidiary for the express purpose of providing appropriate insurance. Time Inc., for example, possesses its own insurance company, which provides coverage for all Home Box Office events. Advantages of this option include the fact that the insurer is not affected by market pressures, administrative costs are reduced, and the subsidiary can serve as a tax write-off for the parent company.

It is possible that even if manufacturers and owners of space systems adopt some of the risk, the commercial insurance market will be unable to meet demand. If this shortage occurs, the U.S. government may have to consider becoming an "insurer of last resort." This possibility does not seem likely in view of the philosophical reluctance of the current administration to expand the government's role in areas traditionally the province of private industry. However, the need to support commercial space activities could override governmental reluctance if fear of "collapse" were strong enough.

Under appropriate circumstances, then, the government could serve as an underwriter for launching parties that could not obtain insurance in the marketplace. Several options exist whereby the government could act as an insurer. For example, if capacity were the problem, the government could maintain a floating rate set a certain percentage above market rates, allowing users to turn to the government as a last resort.

An obvious source of danger in having the government insure space activities is that the market loses influence over the level at which rates are set. For example, should the government choose to place a "cap" on rates in order to assure access by smaller entrepreneurial firms to adequate insurance, the industry could claim that it was being coerced and that rates were being set by nonmarket forces. Although it seems likely that forms of co-insurance or self-insurance will become more common for satellite owners and manufacturers, barring further major losses government participation in the industry is not considered likely. However, the dynamics of the space insurance market indicate that a significant loss in the near future may be sufficient to create a situation that would require government intervention.

Conclusions

We believe that current trends in the space insurance industry lead to the following conclusions:

- Insurance rates will rise substantially, reflecting the impact of record losses and continuing strong demand for coverage.
- A lead-lag relationship will probably exist between a rise in rates and expansion of insurance capacity. In other words, recent losses have resulted in a near-term contraction in capacity. We expect that capacity will subsequently increase as rates rise and demand remains strong.
- Another major satellite loss in the near term could cause a significant contraction in underwriting capacity.
- If such a contraction were to occur, one of the alternative insurance scenarios previously discussed may be necessary to provide adequate coverage.

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ERRATA SHEET

Inadvertently, the Committee Print fails to attribute the Appendix on page 29 to its authors, Shearson Lehman/American Express, Inc./Center for Space Policy, Inc. The Committee is grateful to the authors for their permission to reprint this article and to include it in the Committee Print.

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